REPORT ON PLANTATIONS on the ESTATES of His Grace the DUKE of RICHMOND in the COUNTY of ABERDEEN.

By Mr GEORGE M'PHERSON, Huntly.

[Premium—The Gold Medal.]

THESE plantations were formed between March 1839 and May 1844, and they extend over a space of 2,442 imperial acres. Thus—

1*st*, Binhill and adjacent moors, 2,258 imperial acres, besides 45 acres occupied by a peat-moss and a road leading to the same.

2*d*, Hill of Drumdelzie, 117 imperial acres, lying in the immediate vicinity of the above, and, in fact, a portion of the same moors.

3*d*, Culdrain plantation, 41 imperial acres, being a detached piece of planting lying in the parish of Garthy, and not specially adverted to in the following report.

4*th*, Various clumps and belts in different portions of this district of his Grace's property, for the ornament and shelter of different farms, 26 imperial acres.

The Binhill and adjoining moors are situated in the parishes of Cairnie and Huntly in Aberdeenshire, and are distant from the town of Huntly about one mile. They extend from the turnpike road leading from Huntly to Keith on the west, to the turnpike road leading from Huntly to Portsoy on the east, measuring in one straight line $2\frac{3}{4}$ miles, and from north to south at the widest extremities about $2\frac{1}{4}$ miles.

The ground is much diversified, presenting a variety of irregular rocky hills, known as the Binhill, Ordquhill, Clean Cairn, Boddamhill, Ordhill, and its elevation varies from 300 to 1000 feet above the level of the sea.

The surface of the ground is either rocky, or covered with earth-fast stones, some of them of immense size, measuring over the top from 30 to 50 links. It was thus altogether unsuitable for tillage, and, until planted, had been pastured as a common by the sheep and cattle principally of the smaller tenants and crofters adjacent.

As might be expected on such an extent, the diversity in the kind and quality of the soil is very considerable. Many parts, particularly of the eastern slopes, are composed of a rich brown loam, well adapted for the growth of hard wood. In some of the lower level parts there are deposits of peat, but only to any considerable extent in the hollow which intersects the planta-

tion and divides the Binhill from Ordquhill. The greater portion may be termed a good moor soil, with scarcely any traces of moor-band, or that poor, dry, black heathy peat, so common in many similar altitudes.

Before being drained there were considerable portions of marshy ground, particularly in the Ordquhill division and on the north and west sides of the Binhill. A very great extent, however, of surface-drainage was effected in these parts, which now, instead of acting as reservoirs of rain-water, are relieved of the superabundant moisture as it falls, often with a rapidity somewhat inconvenient for those whose thrashing-mills a slower and more constant discharge would suit much better.

The admirable adaptation of the greater portion of this large tract of waste ground for the growth of most of the common forest trees, the scarcity of timber, both for agricultural and other purposes in the district, and the manifest advantages which it would afford both as shelter and ornament to a surrounding district of no inconsiderable fertility, and of rapidly advancing improvement, induced the proprietors of the Gordon estates, for a number of years, to reserve this tract for planting. Shortly after the succession of the Duke of Richmond to these estates, his Grace resolved to carry that purpose into effect; and, in 1838, Messrs Beattie and Walker, land-surveyors in Aberdeen, were employed to make a survey and plan of the ground, and to prepare specifications of the work, of which the following is a copy:—

Specifications of the manner of Planting the Binhill and adjacent Moors.

The ground is divided into lots, to be contracted for either separately or together. There are several varieties of soil interspersed with one another, which are classed for planting in the following order:—

Class I.—Wet gravelly clay, retentive of water. Distinguishable by greenish benty grass.

Class II.—Deep, rich, damp soil, some parts swampy. Distinguishable by a greensward, with open long heather.

Class III.—Friable loamy soil on the low grounds, on a dry porous subsoil. Distinguishable by short open heather, with an under greensward of the finer grasses; contrasts in colour, and is interspersed with Class I., in irregular patches of small rising grounds.

Class IV.—High grounds, parts of which are very rocky, with friable loamy soil of good quality, partly exposed, and partly sheltered. Distinguishable by short open heather, with green

undersward; soil light and soft, of a brown or yellow colour; high rocky ridges, and sheltered ravines and hollows.

Class V.—Banks along the base of the rising grounds, and along the turnpike roads, adapted for hard wood. Distinguishable by a deep soil, with short heather or greensward, some parts growing ferns.

The ground above described is to be planted with trees of the following descriptions:—

Class I.—With seedling larch and Scots fir, 2 years old, mixed in equal quantities.

Class II.—With spruce and silver firs, 3 years old, from the seed-bed.

Class III.—With Scots firs only, 2 years old seedlings.

Class IV.—With larch, 2 years old seedlings.

Class V.—With hard woods, oak, elm, ash, birch, beech, in equal quantities, with a few planes, chestnut, maple, and others, for ornament, along the turnpike roads, all to be 4 years old, and transplanted two years. The oak and elm to be planted in the finest soil; the ash in damp and low land; the birch and beech in the greatest quantities on the higher grounds, and a mixture of two years transplanted larch, Scots firs, and spruce.

The plants must all be healthy, strong, full-budded, and fibrous rooted, and the several kinds as uniform in size as possible. The 2 year old seedlings to be planted with the planting-spade or dibble; the spruce and two years transplanted firs with the garden spade; the hard wood to be planted in pits of 16 inches wide by 12 inches deep, properly prepared at least two months previous to planting. The pits to be executed by the contractor, and the expense included in his estimate. The plants and manner of executing the work to be subject to the approval of the employer's inspector.

The contractor must become bound to furnish the plants, execute the planting and pitting, and perform all carriages, with every attending expense relative thereto, by the 20th of December 1839. Also to uphold the planting for the period of four years after the whole is completed, by planting up blanks or parts where the trees may be found unhealthy, when called upon to do so, with plants of the same age and description as formerly planted.

Estimates to be given for each lot separately, per slump sum, in terms of the above specifications and following table, and the contractor must grant security for his implementing the bargain, and payments will be given as the work proceeds, on the order of Mr James F. Beattie, land-surveyor in Aberdeen, to whose satisfaction the work must be completed and upheld for the period above stated;

Table shewing the Extent of each Lot and Number of Trees to be Planted.

Classes of Soil as described above.	Description of Trees.	Lot 1. N.W. side of Binhill.			Lot. 2. S.W. side of Binhill.			Lot 3. N. side of Binhill			Lot 4. E. side of Binhill.			Lot 5. N. Ordquhill.			Lot 6. S. Ordquhill.			Lot 7. Boddamhill.		
		Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.	Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.	Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.	Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.	Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.	Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.	Number per Acre.	Extent, Imperial Acres.	Total Number of Trees.
			A. R. F.			A. R. F.			A. R.			A. R. F.			A. R. F.			A. R.			A. R.	
I.	Scots Firs and Larch, 2 years seedlings,	3,000	240 2 6	721,612	3,000	205 3 34	617,888	3,000	150 0	450,000	3,000	206 2 18	619,837	3,000	220 1 23	661,180	3,000	307 3	923,250	3,000	60 3	182,250
II.	Spruce, 3 years old seedlings, . . .	2,500	40 0 0	100,000	2,500	5 0 0	12,500	2,500	40 0	100,000	2,500	50 0 0	125,000	2,500	40 0 0	100,000	2,500	40 0	100,000	2,500	20 0	50,000
III.	Scots Firs, 2 years old do., ...	3,000	40 0 0	120,000	2,500	20 0 0	50,000	2,500	55 0	137,500	2,500	40 0 0	100,000	2,500	30 0 0	75,000	2,500	60 0	150,000	2,500	8 0	20,000
IV. Exposed	Larch, do.	3,000	30 0 0	90,000	3,000	20 0 0	60,000	3,000	15 2	46,500	3,000	30 0 0	90,000	3,000	10 0 0	30,000	3,000	20 0	60,000	3,000	20 0	60,000
Sheltered	Do. do.	2,500	14 0 0	35,000	2,500	12 0 0	30,000	2,500	13 0	32,500	2,500	16 0 0	40,000	2,500	25 0 0	62,500	2,500	40 0	100,000	2,500	17 0	42,500
V.	Hardwood, 4 years transplanted, . .	500	4 0 0	2,000	500	30 0 0	15,000	..	..	..	500	20 0 0	10,000	500	10 0 0	5,000	500	21 0	10,500	500	10 0	5,000
	Larch, 2 years do.	750		3,000	750		22,000	..	..	..	750		15,000	750		7,500	750		15,750	750		7,500
	Scots Firs & Spruce do.,	750		3,000	750		22,000	..	..	..	750		15,005	750		7,500	750		15,750	750		7,500
			368 2 6	1,074,612		292 3 34	830,388		273 2	766,500		362 2 18	1,014,837		335 1 23	948,680		488 3	1,377,250		135 3	374,750

	Acres.	*Trees.*
Total, . .	2,257 : 2 : 1.	6,387,017.

and if any difference or misunderstanding arise between the employer and contractor as to the meaning of the above specifications, the same to be referred to the said Mr James F. Beattie, or to any other competent person, to be named by the sheriff of the county, whose decision shall be final and binding on both parties. The employer will fence the ground, and cut such ditches and drains as he may think necessary; also clear off the brush-wood and whins.

200 yards from the line of the exterior fence are reserved during the summer for supplying materials for building the fence; and to be planted in autumn.

Contracts were thereafter advertised for, and six offers for planting, either the whole or a portion of the ground, having been received, an agreement was entered into with Messrs Peter Lawson and Son, seedsmen to the Highland and Agricultural Society, Edinburgh, who contracted to execute the whole work for the sum of £1956 sterling, payable on 15th May and 20th December 1839, and 15th May and 20th December 1840, in the proportion of the amount of work completed at the foresaid dates respectively, to be ascertained by an inspector named in the contract, but deducting from the last payment the sum of £100, which were stipulated to be retained for five years from 20th December 1840, and then paid with interest, at 3 per cent. per annum, on a certificate by the said inspector that Messrs Lawson and Son had completed their part of the contract.

The planting having been thus agreed to, the ground was enclosed with stone fences, in the shape of what is called a Galloway or rickle dyke, 3½ feet high, the large stones composing the fence being firmly but roughly put together, the angular points projecting in such a way as to present a far more formidable obstacle to either cattle or sheep than a more regularly built dyke of the same height. These fences, at 6d. per yard, cost in all, carriage of materials included, £464 : 4 : 3.

At the same time, the wet part of the ground, which may be estimated at one-half of the whole, was surface-drained, by small drains cut diagonally across the slopes, and directed into the natural hollows or streamlets. These drains were from 1 to 2 feet deep, 1 foot wide in the bottom, from 18 inches to 3 feet wide at the top, according to the depth; the surface was cut into turf, which was laid regularly along the lower edge of the drain, leaving a scarcement of about 6 inches, the earth being thrown on the turf. This part of the work was mostly executed by labourers at day's wages, under the constant superintendence of an overseer, and cost £225 : 15 : 7.

A road, 15 feet wide, having a ditch and turf fence on one

side, and a smaller ditch on the other side, was also executed, at a cost of £180, for the purpose of giving access to the moss, from which a number of the surrounding tenants obtain fuel, and also of ultimately facilitating the driving of timber out of the wood when it should require thinning. The alders and whins, also, were grubbed up on various parts of the ground, where they would have interfered with the trees specified to be planted, at a cost of £54 : 0 : 9. The labourers were employed at this work at day's wages, under the superintendence of an overseer.

The total expense was as under :—

1. Estimate for planting, ...	£1,956	0	0
2. Enclosing, at 6d. per yard, . . .	464	4	3
3. Making road, ...	180	0	0
4. Draining, ...	225	15	7
5. Grubbing up alders and whins, . .	54	0	9
6. Expense of survey, &c. . . .	76	12	11
Total, ...	£2,956	13	6

Or very nearly £1 : 6 : 2¼ per acre.

All necessary arrangements having been completed, Messrs Lawson commenced planting the Boddamhill Lot, 7, in March 1839, and when they ceased planting in May, had completed the whole of Lots 7, 2, 3, and 4, except an irregular belt round the outsides, left to furnish stones for the fence dykes, as also fully more than the half of Lot 1. In November following they resumed planting, and, the weather proving very favourable, were enabled to complete the whole by the 20th December, with the exception of a very few acres in parts where the fences were not altogether completed. During the period they were engaged in the work, Messrs Lawson had in their employment from 50 to 80 men and boys.

With the exception of the hard wood and larger transplanted coniferæ, all the plants were put in by means of the planting-iron, and, being so small as scarcely to be observed among the heather and herbage, the planters, to ensure regularity in their operations, were divided into bands of from 12 to 20, stationed at the proper distance apart, and preceded by a boy, whose duties were to measure and mark off the ground by *two* or *three* lines of white pins, according as the number of planters and the nature of the ground made necessary. Each band was also followed by a foreman, to see that the work was done in a regular and efficient manner. The masses of larch, Scots fir, and spruce, were irregularly blended together, to prevent all stiffness in their outlines, often consequent upon the dibble or hand-iron planting of small trees, and care was taken, as far as possible, to arrange so as the planters should move *across* the lines of view from the

public roads and particular points in the surrounding country; and certain previously formed peat-moss roads through various parts of the country were left unplanted, both for the purpose of continuing convenient access to fuel to those localities which the new-made road above noticed did not suit, and for the purpose of ultimately affording facilities for the removal of the timber. These roads, however, are by no means sufficient in number for the latter purpose, and it is therefore intended, in the course of two or three years, to mark and clear off the wood in proper lines with this view, leaving the more laborious operations of levelling, &c., till the roads are actually required.

In October 1840 the state of the various divisions of the plantation were, after a minute and careful examination, reported on as follows:—

Lot 1. Contains by far the greatest portion of inferior wet soil, which, from its stony and shallow nature, would never repay thorough draining. A few additional drains might, however, be made in the peaty grounds opposite the Manse of Cairnie, as well as in some small portions between the manse and the higher parts of the hill, and eastward in the direction of Mortlach.

Lot 2. Also contains some very inferior wet ground east from Binside, together with a good deal that would be the better for more complete draining, particularly that corner where the plantation joins the Inverness road, the flat marshy ground between the same and the higher parts of the hill, a small marsh behind the *Cave Craig*, and several pieces along the south side, near the road.

Lot 3. Is still wet in several parts inside the east dyke and in the large hollow north-east of the summit of the Binhill.

Lot 4. Will still require a considerable number of short drains in all the hollows along the east slope, or next the Moss-side road, as well as in the marsh on the higher ground north-west of Ordhill, and downwards to where the alders grow on the side of the Inverness road.

Lot 5. A considerable number of drains will still require to be introduced in the marshy ground east from Widow Watt's house, and downwards in the direction of Haggieshall, as also along the Portsoy road, and in the small corner on the east side thereof. In the damp parts of this and the next lot the young Scots firs have suffered more than anywhere else, and will require to be replanted in spring.

Lot 6. Will still require considerable additional draining in the large marsh below the top of Ordquhill and Roddentree, as also eastward and along the side of the Portsoy turnpike road. Another marsh of considerable extent, in a line between the summit of Ordquhill and Ordhill, commencing pretty high on

the former and diverging towards the line of an old road from Boghead Park towards William Dawson's, in Lot 5, is still very wet, and a considerable addition of good soil for trees would be gained by forming the proposed cut through the moss, and drying the adjacent cut by means of side drains, a considerable portion of which was planted last spring, but has failed in consequence of the extreme moisture.

Lot 7. Is, on the whole, pretty dry, but would be the better for a few additional drains at the south and north corners, as well as in the old park north of Boghead.

At the date of this report, the plantation was considered as thriving pretty well, unless in the marshy places, and in those portions where the process of planting had been continued too long into spring, and where the plants suffered considerably when the drought set in. In consequence of the remarks in this report in reference to draining, a considerable additional outlay to that originally made was incurred in effecting the drains pointed out, the expense of which, however, is included in the statement given above.

After finishing the first planting in December 1839, a few scores of a thousand plants continued to be put in from time to time, where the failures appeared most evident; but it was not until the spring of 1842 that the "beeting up" was regularly commenced. This was done in March and April of that year, most of the ground planted in 1839 being gone over, the number of plants required for that purpose being from a-fourth to a-third of that originally planted. In the following spring the remainder was completed, chiefly in the eastern or Ordquhill division, in many parts of which the proportion of failures was considerably greater than in other portions of the ground, arising partly from the wet nature of the ground, from the planting having been executed when the autumn rains had saturated the soil with water, before the draining had been thoroughly completed—partly from the strong growth of herbage which the superior nature of the soil had in many places yielded, and for which the plants originally specified proved too small—and partly also from the severe drought which followed the planting in spring. In replanting these portions, one and two years transplanted larch and Scots fir, and two and three years transplanted Norway spruce, were used.

In May 1844, the various divisions of the ground were again minutely gone over, and the following report made on their condition.

Lot 1. *About* 368½ *acres on the north-west or Carnie side of the Binhill.* Towards the north-east side of this lot there are from 40 to 50 acres of rough sedgy and wettish ground, in which

the existing trees are about one-fourth deficient, or, in all, about 30,000.

Lot 2. *About* 293 *acres on the south-west of the Binhill.* The plants in this division are, upon the whole, in a very satisfactory and thriving condition; but about 4,000 will still be required to thicken 5 or 6 acres of wettish ground, principally situated near the top of the hill, and contiguous to the east boundary line.

Lot 3. *About* 213 *acres on the north and north-east side of the Binhill.* Will require making up to about the same extent as the last—4,000—chiefly on wettish ground contiguous to the next lot; all the young plants here, but especially the Scots firs, are doing remarkably well.

Lot 4. *About* 362½ *acres on the east and south-east side of Binhill.* In several wettish patches towards the lower parts of the ground, containing in all about 12 or 15 acres, plants to the extent of about one-fourth, say 10,000, will still be necessary to make up deficiencies to the originally required thickness.

Lot 5. *Northern Ordquhill division, measuring about* 335 *acres.* In this lot the greatest failures of young plants have taken place, extending over from 20 to 25 acres of damp and very rough sedgy ground, formerly a very wet marsh. About 12 acres in this lot will still require fully half the originally specified number of plants, or 18,000, and the remainder about one-fourth, or 10,000, in all 28,000.

Lot 6. *Southern Ordquhill division, containing* 488 *acres or thereby.* Over the whole of this division not more than 8 or 10 acres now require thickening up, for which 8,000 plants will be sufficient. These deficiencies are chiefly confined to two parts, viz., the top of a large tract of damp rough sedgy ground on the east, and another tract of similar ground on the west side of the ridge, lying between the top of the hill and Cleanpool. It may be remarked that the natural unsuitableness of a great portion of this division (situated within view of Huntly Lodge) for seedling plants induced the contractors, at considerable additional expense to themselves, to use transplanted plants in the drained marshy grounds, throughout which the first planting of seedlings were almost entirely destroyed by the overgrowing herbage and the then prevailing moisture.

Lot 7. *Westertown or Boddamhill, about* 136 *acres.* On the whole of this lot the young plants are doing remarkably well, with the exception of about 5 acres of marsh, called Boghead Park, and another acre or so contiguous to the same, which will still require further drainage in some parts, after which it should be planted with about 3,000 birch, 2,000 alder, 3,000 willows of sorts, and 3,000 poplars of sorts. The last two are best suited

for the parts where the rushes and grass are strongest, the willows being kept as much as possible on parts where the least proportion of peat enters into the composition of the soil.

From the preceding statements it will be seen that about 95,000, or say 100,000 plants (less than a sixtieth part of the originally estimated number) are still required to make up all the parts of the ground to the thickness stated in Mr Beattie's specifications. This quantity, large as it is, must, however, appear trifling, when it is considered that almost the entire deficiency is confined to portions of the ground unsuited for the kinds of plants originally specified, and that at least twice the same extent of ground was of a nature unanswerable for planting with seedlings of the different ages stated in the specifications, the plants having been too small for contending with the strong growth of grass which arose after planting, and which was not calculated on when the land was in an undrained state and constantly in pasture. The consequence of this oversight has been the incurring an additional expense of 260,000 larch, 340,000 Scots fir, and 50,000 spruce, one and two years transplanted.

In concluding this report, Messrs Lawson & Son recommend that the planting should be filled up, in autumn 1845 or spring 1846, with birch and alder at least two years transplanted, except in the case of Lot 7, by which time the plants still living will not only be distinctly seen, but will afford a considerable degree of shelter.

It remains only to be added that, in the past summer of 1844, the plantation has made rapid progress, excepting in those parts of the ground where, from various causes, the plants have failed to some extent, and that the Binhill, and moors adjoining it, already begin to assume something of a clothed appearance.

PROCEEDINGS OF THE AGRICULTURAL CHEMISTRY ASSOCIATION.

The Committee of Management now transmit to the Directors of the Highland and Agricultural Society of Scotland, for publication in the next Number of their Transactions, an Account of some of the Investigations carried on in the Laboratory of the Association since their Report in July 1845.

This account embraces a very small proportion of the analyses made during the last six months by the Chemist of the Asso-

ciation and his assistants, and is intended only to explain some of the more interesting practical results obtained by them in the course of their investigations.

The account has been drawn up by Professor Johnston, in a series of articles applicable to the several subjects noticed, and forming a continuation of those in the two previous reports.

D. HORNE,
Honorary Secretary.

EDINBURGH, 1*st December* 1845.

XI.—OF THE COMPOSITION OF LIQUID MANURE.

The liquid manure of our farm-yards is now attracting more general attention than at any former period, and tanks for collecting it are in course of erection in various parts of the country. Both theory and experiment shew this liquid to be very valuable as a manure, and it has been long known to contain substances fitted in a marked degree to promote the growth of plants. Still, no analyses, so far as I am aware, have hitherto been made of the liquid in the state in which it actually exists in our farm-yards, and in too many cases runs to waste.

It was with much satisfaction, therefore, that I received, a few months ago, two bottles of liquid manure for analysis from Mr Houldsworth of Coltness, near Hamilton, a member of our Association. This gentleman had drawn up, for distribution among his tenantry, a very satisfactory and useful statement in regard to the value of this liquid, and the gain which would accrue from saving it. But, before circulating his paper, he was desirous of having the actual liquor of which he spoke carefully analysed, and he therefore forwarded it to the laboratory of the Association. The examination has led to some interesting results, which I think deserving of general publication.

1°. The liquid contained in the first bottle consisted of the drainings from heaps of cow-dung exposed to rain. It was dark coloured, and, of course, contained only what rain-water is capable of washing out of such dung-heaps. It was neutral, but ammonia was given off when it was boiled, or when quicklime was added.

An imperial gallon of these drainings, when evaporated to dryness, left about 480 grains, or an ounce weight, of dry solid matter. This solid matter consisted of—

Ammonia, ...	9.6 grs.
Organic Matter, ...	200.8
Inorganic Matter, (ash,)	268.8
	479.2 grs.

The inorganic portion consisted of—

Alkaline Salts, ...	207.8 grs.
Phosphates of Lime and Magnesia, with a little Phosphate of Iron, ...	25.1
Carbonate of Lime, ...	18.2
Carbonate of Magnesia and loss, . . .	4.3
Silica and a little Alumina, ...	13.4
	268.8 grs.

From this analysis it appears that the rain is capable of washing out much valuable matter from common cow-dung. The ammonia is not so large in quantity as in many other forms of liquid manure; because most of those substances voided by the cow, which are capable of producing ammonia, pass off in its urine. But, on the other hand, the urine of the cow contains no phosphates, while these washings contain a considerable proportion. It thus appears that the washings of the dung-heaps contain other valuable substances besides those which are present in the urine. Those, therefore, who besides allowing the urine from their byres to run to waste, permit the rain to wash their dung-heaps, suffer a double loss; they lose the ammonia-producing substances, and much alkaline matter in the urine, and the phosphates, with a large additional portion of alkaline matter in the washings.

2°. The second liquid consisted of the drainings of farm-yard dung when watered with cow's urine. It was also neutral, but gave off ammonia copiously when boiled or when mixed with quicklime.

An imperial gallon, when evaporated, left 617½ grains of dry matter, considerably more than the former liquid, and this matter consisted of—

Ammonia, ...	21.5 grs.
Organic Matter, ...	77.6
Inorganic Matter or ash, . . .	518.4
	617.5 grs.

We see here that the relative proportions of organic matter in the two liquids were very different. From ordinary farm-yard manure, there is, as we should expect, less of the organic part dissolved by water than from the finely masticated and digested excretions of the cow.

The inorganic matter contained in this liquid consisted of—

Alkaline Salts, ...	420.4 grs.
Phosphates of Lime and Magnesia,	44.5
Carbonate of Lime, ...	31.1
Carbonate of Magnesia and loss, .	3.4
Silica and a little Alumina, . .	19.0
	518.4 grs.

In this liquid, therefore, as in the other, there was a considerable proportion of phosphates, as well as a large amount of alkaline salts. There are no phosphates in the urine; but the fermentation of the dung-heap, caused partly by the watering with the urine, decomposes the straw and other substances which form the dung-heap, brings a portion of the phosphates they contain into a soluble state, and thus enables them to be washed out by any watery liquid that comes in contact with them.

The urine of the cow, therefore, which has been thrown upon the dung-heap will pass off, if it is allowed to escape, richer than it was at first. It may not contain so much ammonia, or of those substances which produce ammonia, but it will carry away more of those inorganic substances which enter into the composition of our crops, and which are no less necessary to their growth.

XII.—CAN THE FERTILIZING SUBSTANCES BE EXTRACTED FROM LIQUID MANURE?

The insertion of the above analyses leads me to advert to a question which has several times been put to me by members of the Association, and which has been specially recommended to my consideration by the Committee of management. Liquid manure is of large bulk, is expensive to carry to the field, and cannot be applied at every season of the year. Is it not possible, therefore, to extract from it all the fertilizing substances it contains, and to preserve them in a dry and portable state for after use? Could such an object as this be effected, it would be a valuable boon to the practical man, and, in leading to a more general saving of the liquid manure, would not be without its value to the state.

But that a method for thus extracting the virtues of liquid manure may be of use several conditions are required. Thus—

1°. It must be perfectly efficient. If a method were recommended which should merely separate one portion of the substances or one kind of matter from liquid manure, while it left the rest behind, it would only lead to a more general waste than now exists, in so far as it would induce many to believe that, a part being thus extracted, the fluid which was left might be allowed more freely to run to waste.

2°. It must be easy of execution. A process which involves much trouble would not generally be adopted by practical men, and if it were difficult to perform, it would be imperfectly done. These drawbacks would cause the method to fail; it would consequently fall into disrepute, and the advantages of scientific knowledge and skill would sink in public estimation.

3°. The materials employed for the purpose must be abundant,

cheap, and easily accessible everywhere. This is the most difficult condition to fulfil, and it presents the greatest bar to the introduction of any economically useful method of effecting the object in view.

The only substance at present known, by which the separation of all the valuable ingredients from liquid manure can be fully effected, is animal charcoal. A sufficient supply of this substance, when intimately mixed with the liquid manure, will take up nearly the whole of the saline and colouring matters it holds in solution, will carry down the substances it holds in suspension, and will leave the water nearly pure and colourless. The refuse of the prussiate of potash manufactories will have this effect, and what remains when ivory black is digested in spirit of salt (muriatic acid) will do still better. But this kind of charcoal is neither cheap nor abundant, and therefore cannot be recommended to general use. The refuse animal charcoal of our manufactories is now sold as a manure, at the price of several pounds a ton; either those who sell or those who use it might render it still more valuable by causing fermenting liquid manure to filter through it before it is applied to the land.

But other kinds of charcoal possess this property to a certain extent. Wood charcoal reduced to powder, charred saw-dust, and charred peat, are all capable of being used with advantage in extracting the ammoniacal and other salts which give its value to the liquid of our farm-yards. Experiment has shewn that, when filtered through a bed of such charcoal, the liquid escapes without colour and almost without taste, while the charred peat or saw-dust is itself converted into fertilizing manure. Wherever such charcoal, therefore, can be obtained in abundance and at little cost by the practical farmer, this mode of employing it may be both useful and profitable to him. Saw-dust or peat may also be mixed with earth and charred, when the heap, after being several times drenched with liquid manure, will be converted into a valuable compost.

Still it will be uncertain that the liquid thus treated has been deprived of all the fertilizing substances it contains. Even when it passes off perfectly transparent, colourless, and without smell, it often, indeed almost always, contains in solution both organic and inorganic substances, which are useful to the plant. That it contains soluble organic matter is shewn by its again becoming muddy, and fermenting, when allowed to stand for a considerable time, while the inorganic or saline substances are readily detected by evaporating the clear liquid to dryness.

However beneficial, therefore, the use of such forms of charcoal may be, we can scarcely consider it, in almost any circumstances, as likely to effect a saving of the whole of the

valuable matters contained in our liquid manure. A great portion of the loss now incurred may be prevented by the use of such kinds of charcoal, and the fertilizing substances may, through their means, be applied to our crops, at seasons of the year for which, in the liquid form, they are not suited—still the application of the whole liquid to the land would return to the soil more of what the crops had carried off, and would thus keep it longer in a state of fertility without the aid of foreign manures.

Various other substances have been recommended and used for the purpose of extracting from the liquid of the farm-yards, from urine, and from the water of our common sewers, the different chemical compounds they are known to hold in solution. Thus, burned and powdered gypsum, when intimately mixed with such liquids, falls for the most part to the bottom, carrying with it a greater or less proportion of the matters which the water had previously dissolved. This powder, when collected and dried, forms the principal part of what is known in the manure-market under the name of *urate*, and is more or less valuable according to circumstances. But it always leaves in the liquid much more than it extracts from it, and hence goes but a little way in saving what the liquid manures contain.

Again, if alum or sulphate of magnesia, (Epsom salts,) or sulphate of zinc, or sulphate of iron, (green vitriol,) be mixed with fermenting urine or tank-stuff, a powdery matter, more or less dense, will fall to the bottom, which will contain the phosphates and a portion of the other saline and even of the organic constituents of the liquid. This powder, therefore, may be used as a manure, either alone, or, what is better, in admixture with other fermenting manure; but all these substances leave most of the valuable salts in the water behind them, and, therefore, besides their cost, are open to the objection that they do not perform the purpose for which they have been employed.

This latter objection applies more strongly to slaked lime, which does indeed carry down much of what the liquid holds in suspension and in solution, such as the phosphates and much of the organic matter, but it leaves behind all the ammonia, and even decomposes the ammonia-producing substances which those liquids contain, and causes their elements to be more speedily dispersed through the air.

On the whole, therefore, it does not appear that at present we are likely to obtain any means of *completely*, *easily*, and *cheaply* separating the fertilizing ingredients of our tank-stuff from the water in which they are dissolved. It is not likely, indeed, that any generally available means will be soon discovered by which these fertilizing substances can be wholly extracted in a dry form equal in manuring value to the liquids themselves as they flow from our farm-yards.

The method of absorbing the whole liquid by partially dried peat, and thus adding to the quantity of fermented manure at the disposal of the farmer, is perhaps a better, as it is certainly an easier way, of using up the liquid manure where peat abounds, than the method of using charred peat to separate its constituents. This method is very extensively employed both in Ireland and in Scotland, the only objection being, that the manure is not so portable as that which may be obtained by the use of peat in a half charred state. The use of peat, indeed, in our dung-heaps cannot be too generally recommended. It prevents the escape of ammoniacal and other volatile substances, it absorbs disagreeable odours, and renders the neighbourhood of dunghills less unpleasant and unwholesome. It is probably owing to the copious use of peat in this way that so little injury arises to the health of the peasantry of Ireland and of parts of Scotland, from the dung-pit so often seen before the doors or beneath the windows of their cottages.

XIII.—OF THE COMPOSITION OF BARLEY, AND OF THE DIFFERENCE BETWEEN POT AND MALTING BARLEY.

A few months ago my attention was drawn, by Mr Johnston of Bathgate, a most zealous member of our Association, to a curious circumstance in regard to barley, with which I had been previously unacquainted. He stated to me that there were certain fields in his neighbourhood which were noted for producing barley which answered well for being converted into pot-barley, while the barley from other fields adjoining them could not be economically used for this purpose. He supposed the difference to be owing to some chemical difference in the composition of the two varieties, connected probably with the nature of the soil, or with the kind of manure applied to it, and he asked me to explain to him in what this difference consisted.

As I was unacquainted with the peculiar qualities which fitted this grain for the purposes of the pot-barley manufacturer, I consulted a gentleman of long experience in the barley trade and in malting, and I obtained from him the opinion that the best barley for malting was also the best for making pot-barley. The plumpest grain, he said, usually malted best, and the roundest and plumpest grain was also subject to least waste when manufactured by the miller into the common *pot* or into *pearl* barley. This answer satisfied me that the point put to me by Mr Johnston, and which was new to myself, was also not generally known or understood even by persons otherwise skilful and experienced in the general qualities of barley. In stating, therefore, to Mr Johnston the result of my inquiries, I asked him to supply me with further information upon the subject; and, if he conveniently could, to send me a sample of each of the varieties which in his neighbour-

hood were considered best adapted respectively for malting and for making into pot-barley. In reply I obtained from Mr Johnston the following letter:—

BATHGATE, 16*th August* 1845.

DEAR SIR,—I had the honour to receive your valuable communication of 8th ultimo, for which I beg to thank you. I was also favoured with your subsequent note regarding the statement I made in the letter I addressed to you, as to the greater or less plumpness of different samples of barley for the manufacture of pot-barley and for malting. The person you mention as having spoken to respecting the difference, I have no doubt is well acquainted with the barley market; but it is possible the difference referred to may not have come under his notice. The roundest and plumpest grain may in *general* be the best for malting, as well as for making pot-barley; but from the information I have through two persons of much experience in their respective lines, the one a distiller, the other a maker of pot-barley, I am convinced that of two samples of equal weight, the one starchy and the other flinty, the former will be found particularly valuable for malting, but not at all suited, from its soft texture, for making pot-barley—the latter, on the other hand, may both malt well and be profitably used for making pot-barley. In order to shew this difference, I beg to hand you two specimens of pot-barley made from different samples, both originally of the same weight, viz., 54 lbs. per bushel. No. 1, made out of the starchy good malting variety, you will observe is much rounded off on the ends and otherwise run down in the process of milling, many of the grains, as if of a softer quality than the generality, being reduced to less than a-half of the regular size, and ground in some cases into forms approaching to square. The grains of No. 2, on the contrary, are much more equal in size, the process of manufacture having acted uniformly on the mass.

As I mentioned formerly, the barley grown on the farm from which No. 1 is taken is much prized by the distillers; on the other hand, that grown on the farm producing No. 2, is liked for making pot-barley, and, according *to the report of the barley miller, is worth* 1*s. or* 1*s.* 6*d. per quarter more than the other, at the same weight, for his purpose.* I am not quite so sure as to the distiller's estimate of No. 2, but believe it to malt well. I may mention that both the samples are Scotch grown, of the variety commonly called English, (not Chevallier,) and that No. 1 sample has been grown on the same farm year after year, without being changed for twenty years or more. The miller informs me he occasionally falls in with samples of the same soft or starchy quality grown in other localities, where the seed has been changed. He says he thinks something may be due to the seed, but more to the nature of the soil as a cause.

I have no doubt that the difference referred to has been observed by practical men elsewhere than here, though no notice appears hitherto to have been taken of the somewhat curious fact. I have no doubt you will interest yourself in discovering the cause, and I shall be much gratified to know the result of your investigations, having no doubt of your discovering it. The only conjecture I can form is, that the starchy quality of No. 1 may arise from the want, in the soil, of a sufficiency of nourishment furnishing nitrogen—and this I am led to infer from the circumstance that little manure, except what was made on the farm growing that sample, was ever added to it for many years, notwithstanding it was regularly cropped, and the grain, hay, and dairy produce carried to market. I am not inclined to attribute the difference in any degree to the variety of seed.—I am, &c.

JOHN JOHNSTON.

To Prof. JOHNSTON, Edinburgh.

The above interesting letter shews that the apparent difference between the two qualities of barley is, that the one is soft and starchy while the other is hard and flinty. It is well known that different samples of wheat exhibit similar differences in quality, and that the miller usually requires to mix a quantity of foreign flinty wheat, or of the harder varieties grown in the chalk districts

of the south, with his home-grown grain, before he can grind it with advantage.

As to the cause of this flinty character, and its probable connexion with the proportion of nitrogen in the seed, or of manure containing nitrogen in the soil, the conjecture of Mr Johnston is one which might naturally arise in the mind of a person who has studied the subject with so much interest as he has done. It is said, for example, that hard flinty wheat gives a wheaten flour which takes up more water than that made from softer kinds of grain; and as there is an impression that the power of absorbing water is in some measure proportional to the quantity of gluten which flour contains, it would seem to be probable that the quantity of water absorbed might conversely be assumed as an index of the proportion of gluten contained in a given sample of flour.

And yet there are certain known circumstances which might lead us to doubt whether a flinty sample of grain could be supposed, merely on account of its flintiness, to contain more gluten, and, therefore, more nitrogen. For instance, rice is one of the hardest varieties of grain we know, and yet it is one of those among our cultivated grains which, so far as it has been analysed, is least rich in nitrogen. This fact might lead us to suppose that the hardness of a sample of grain is a proof that it contains less nitrogen instead of more.

Thus, in the absence of analyses, nothing can really be safely conjectured as yet, in regard to the composition of a sample of grain from its hardness or softness compared with others. I was, therefore, very much pleased to have the opportunity of testing the supposition of Mr Johnston by submitting the two samples of pot-barley he had sent me to a comparative analysis. I instructed my first assistant, Mr Fromberg, to make an accurate determination of the per-centage of water and of nitrogen they respectively contained. This he has done with the following results:—

	Water, Per ct.	Nitrogen Per cent.		This Nitrogen is equal to Gluten and Albumen. Per cent.	
		Undried.	Dried.	Undried,	Dried.
Soft Barley, . .	13.55	1.21	1.52	8.24	9.53
Flinty Barley, .	13.11	1.21	1.39	7.61	8.76

It thus appears

1°. That the flinty barley contains a very little less water, or, in other words, is a little drier than the soft barley. This we might probably have anticipated.

2°. That the flinty variety contains less nitrogen than the soft variety. The conjecture of Mr Johnston, therefore, is not borne out by the analysis. The difference, however, is small, and *has probably nothing whatever to do with the degree of hardness or softness of the sample.*

I think it very likely that the flintiness which our varieties of grain exhibit, under certain conditions of soil, climate, manure, tillage, &c., is dependant upon other causes than the proportion of nitrogen or gluten they respectively contain. It indicates, I think, merely a peculiar condition, chemical or physical, of the starch which the grain contains, though what conditions are necessary to the production of this state of the starch I am unable as yet to explain.

I have been told that certain qualities of barley are also preferred for grinding into barley-meal. I should be obliged to any of our members who would inform me what these qualities are, and how far they coincide with those which render barley valuable to the maltster or to the manufacturer of pot-barley.

XIII.—OF THE USE OF BARLEY-STEEP WATER AS A MANURE.

It is well known to makers of malt, whether for the purposes of brewing or of distilling, that the water in which barley is steeped, preparatory to its being made to sprout, extracts a considerable quantity of matter from the grain, and often becomes very dark in colour. The water in which the grain is steeped is changed once or twice, and when drawn off is allowed to run to waste. My attention having been drawn to this point by some members of the Association, I obtained from a maltster in Edinburgh a portion of the water of the first steeping, in the state in which it is usually run off into the drain, in order that, by sub mitting it to analysis, I might be able to answer a question put to me by some of my correspondents—Is this water capable of any useful application as a manure?

When evaporated to dryness, this steep-water left a solid resi due, amounting from an imperial gallon to 413.6 grains. On analysing this solid matter it was found to consist of—

	In a gallon.	In 100 of the solid matter.
Organic Matter, Gum, Sugar, Portein Compounds, &c., .	166.40	40.23
Alkalis and Alkaline Sulphates, and Chlorides, ...	198.84	48.07
Phosphoric Acid in the state of Alkaline Phosphates, . .	8.52	2.06
Phosphates of Lime and Magnesia, ...	23.20	5.61
Carbonate of Lime, ...	15.36	3.48
Loss, ...	1.28	0.55
	413.6	100.00

It thus appears that this steep-water contains much valuable matter of a kind likely to promote the growth of plants. The

organic matter is capable of supplying organic food—the inorganic matter, alkaline salts, and phosphates—in a state in which they can readily make their way into the roots of plants. It ought not, therefore, to be allowed to run to waste wherever convenience exists for readily applying it to the land.

By referring to a preceding article on the composition of liquid manure, it will be seen that this barley-steep water holds in solution nearly as much solid matter, on the whole, as some of the liquid manures of our farm-yards do, and more phosphates than these sometimes contain. If so much, therefore, can be justly said of the value and of the importance of saving these liquid manures, we may with equal justice recommend that the steep-water in question should not be allowed to run to waste.

It will be understood that the preceding analysis can shew only the *kind* of substances which this steep-water is likely to contain. The *proportion* will vary with the sample of grain, with the purity of the water perhaps, and with the length of time during which the barley has been steeped. It may be stronger or weaker than the water analysed in my laboratory, and, therefore, more or less valuable as a manure. The first steep-water is likely to be the strongest and most valuable.

The above analysis was made in the spring of the present year, and since that time Mr Houston of Johnston Castle, one of our members, and who is always ready to test any new suggestion, has had an opportunity of applying it to a crop of young corn—oats, I believe—and, as he has informed me, with very marked advantage. I would strongly recommend that in the ensuing season others should try its effects both upon corn and upon grass.

XIV.—OF THE USE OF SOUR BEER AS A MANURE.

In connexion with the composition of the steep-water above analysed, it is interesting to consider that of the beer, which is afterwards prepared from the malt—though, of course, the constituents of a gallon of beer will vary very much with the kind and strength of the liquor. A variety of strong ale sent for analysis by a member of the Association was found—

1°. When evaporated to dryness, to leave, from an imperial gallon, $7\frac{1}{4}$ ounces of dry solid matter.

2°. When burned, this dry matter left 5.43 per cent. of ash, or about 170 grains from a gallon. By far the largest portion of the dry residue, therefore, consisted of gum, sugar, and other organic matter, and it is curious to observe that the quantity of inorganic matter left by a gallon of this strong ale was actually

less by one-third than was left by a gallon of the steep-water. Thus, a gallon of the

	Organic.		Inorganic.
Steep Water left	166.4 grs.	and	247 grs.
Strong Ale, "	330.0 "	"	170 "

During the process of steeping, therefore, before it is malted, the barley appears to part with the largest portion of the soluble saline substances it contains.

3°. The inorganic matter of the ale, when analysed, was found to consist of—

	In a Gallon.	In 100 of the Ash.
Phosphate of Magnesia, . . .	53.1 grs.	31.32
Sulphate of Lime, ...	21.8	12.83
Alkaline Salts, soluble in water, .	86.6	50.57
Insoluble Siliceous Matter, . .	9.0	5.28
	169.5 grs.	100.0

This analysis shews that we have the alkaline salts here as in the steep-water, but that the earthy phosphate present was phosphate of magnesia. These substances, as well as the organic matter, are all fitted to feed the growing plant, and, therefore, when beer *becomes sour* in large quantities, it may be of use when applied as a liquid manure. It will increase our estimation of the steep-water, however, to recollect that it is richer even than strong ale in those inorganic substances which form one of the kinds of food without which our present races of plants cannot live.

XV.—OF THE WASTE LIQUOR OF THE POTATO MILLS.

Along with the waste liquor from the steeping of barley I may briefly notice that of the potato mills now so extensively in operation in various parts of the country. The first washings of the pulp of the potato, or the water in which the potatoes are grated, is very rich in saline matter, and in substances (protein compounds) capable of yielding nitrogen to the growing plant. These latter substances are also of a nutritive quality, and the liquor, though it gradually assumes a very dark apparently unwholesome appearance, may yet, in some cases, be found valuable as a drink for pigs and cattle.

At all events, however black it may become, this liquor is capable of useful application as a manure. Being derived from the potato, one would naturally suppose that it would especially promote the growth of the potato crop. This idea was tested in the neighbourhood of a potato mill in Perthshire, on the potato crop of 1843. The liquor was run into the drills, and potatoes were afterwards planted in these drills without any other manure.

The crop came up well, and Mr Binning Home of Argaty informs me that it was equal to that of the other parts of the field to which the ordinary manuring had been applied.

It may not be convenient in some localities to apply it in this manner to the potato crop, but it may in very many cases be employed to water or irrigate the grass and other herbage to which liquid manures are usually applied.

This liquid varies, of course, in fertilizing value according to the quantity of water with which the proper juice of the potato may have been diluted. The solid matter which remains when this liquid is evaporated to dryness has been analysed in my laboratory, and there is no doubt whatever of its fertilizing qualities ; but I delay the publication of the numerical results until the variations in its composition have been determined by a more numerous series of comparative analyses.

XVI.—OF THE PER-CENTAGE OF LIME IN DIFFERENT SLATE-ROCKS.

Soils are formed either from the rocks on which they rest or from rocks which are to be found usually at no very great distance from the spots where the soils themselves are observed. The presence of lime in considerable quantity is almost essential to the fertility of a soil in our climate. When a particular rock prevails, therefore, over a large extent of country, it is not only interesting in itself, but it is important in reference to the improvement of the district, to know what proportion of lime the rock usually contains. If the rock contains little, the soil formed from it must contain little, and, therefore, will require large and continued additions of this substance to bring it into, and maintain it in, a fertile condition.

The slate-rocks which stretch across the whole of Scotland, from St Abb's Head to the Mull of Galloway, are of great interest in connexion with these views. They form a large extent of surface ; and the soils under cultivation over this surface are seen in many places to be directly formed, or to be actually forming, by the crumbling of the rock. Moreover, much of the country, though improvable, is still in a state of nature, and the application of lime is one of the surest means by which this improvement is to be effected. It is, obviously, therefore, of interest to know what quantity of lime the rocks naturally contain, and which they can yield to the soil as their particles crumble down.

There is also another circumstance which gives an interest to this inquiry. In some parts of this slate country beds of marl occur in the hollows and at the bottoms of bogs, which marl was employed in former times for laying upon the land. There are few or no known beds of limestone in the country, whence then

had the lime been derived, the gradual deposition of which had produced these beds of marl? Was it derived from the general slate-rocks of the country? Then these rocks must not only contain lime, but they must contain more in some parts than in others, since these beds of marl are only found in the hollows of particular parts of the country.

During an excursion through the southern portion of this slate country, I collected a number of specimens from different beds of the rock, and at different places, chiefly within the counties of Wigton and Kirkcudbright. These I gave to my pupil, Mr Norton, with a request that he would determine the proportions of lime they respectively contained. Many of them were traversed by white hair-like streaks of carbonate of lime, and nearly all of them exhibited a slight effervescence when treated with acid, shewing that they contained traces of lime in the state of carbonate. The results of the analyses of seven varieties were as follows :—

	1.	2.	3.	4.	5.	6.	7.
Lime in state of Carbonate, per cent.	7.19	0.26	1.98	0.25	0.22	...	0.19
Lime in state of Silicate, ...	0.24	0.62	0.30	1.09	0.43	0.50	...
Total Lime per cent., ...	7.43	0.88	2.28	1.34	0.65	0.50	0.19

The proportion of lime, therefore, in the different beds of this formation is small. In general, therefore, the soils formed from them will be deficient in lime; and hence the reason why in practice it has been found that the addition of lime is an almost necessary preliminary to any successful and permanent improvement of the surface where *these* soils prevail.

At the sametime, it will be seen by the composition of No. 1 that some beds contain what may be called a large quantity of lime, and will therefore form soils that are of a richer character. The waters also that percolate through them, or the springs that rise from among them, will contain a considerable quantity of lime, and they may both sweeten the natural herbage, and, when they collect in lakes and marshy places, may yield lime enough to admit of the gradual deposition of beds of marl.

The old red sandstone slates also vary in the proportion of lime they contain. Such a slate, from the Fotheringham estate, in Forfarshire, gave Mr Norton—

Lime in the state of *Carbonate*, ...	0.39 per ct.
Do. do. *Silicate*, ...	0.87
Total Lime, . . .	1.09 per ct.

The known fertility of certain soils belonging to the old red sandstone formation does not depend merely on the proportion of lime they contain; yet, in the less fertile parts of this formation, the per-centage of lime contained in the rocks exercises a

material influence on the agricultural capability of the soils which rest upon or are formed from them.

XVII.—OF THE COMPOSITION OF THE LIME REFUSE OF THE BLEACHERS, AND ITS USE AS A MANURE.

In the spring of the present year, when the turnip season was approaching, Sir John Ogilvie, another zealous member of our Association, sent to me a portion of the lime refuse of a bleachfield in his neighbourhood, with a request that I should cause it to be analysed, and give him an opinion as to its agricultural value. It was lying at the bleachfield in large waste heaps, and could be had for a merely nominal price. Upon analysis, my assistant, Mr Fromberg, found it, after drying, to consist of—

Organic Matter and a little Water,	18.57
Sulphate of Soda and Sulphuret of Sodium,	14.23
Oxides of Iron and Alumina,	5.07
Carbonate of Lime,	55.18
Siliceous Matter,	6.60
	99.65

Considering the large proportion of alkaline matter as well as lime it contained, I recommended its use in preparing the land for a green crop, or as a top-dressing for grass and especially for clover—in most cases, however, to be used only in the state of compost.

The owners of the works, considering that the large quantity of alkaline matter found was more than their refuse ought to contain, forwarded another sample for analysis, in which about 8 per cent. only was found. The first benefit of my analysis, therefore, was in this case derived by the manufacturer. He discovered that, from an oversight of his workmen, he had hitherto been throwing away what was valuable, and he therefore took measures to have his refuse washed more free from alkaline matter in future. This, indeed, is generally the first result of the analysis of manufacturing refuse, with a view to agricultural purposes, *where such analysis is communicated to the manufacturer.* He finds that some substance which adds materially to its value as a manure can be turned to more profit by himself in another way ; he therefore varies his process in order to save this substance, and thus renders his waste of less value to the farmer. This is, no doubt, an economical result, which it is very desirable to attain and encourage, but it is evidently not the interest of the farmer to be at the expense of such analyses for the primary benefit of the manufacturer.

Yet though more carefully washed, this refuse is fitted to be of

much use, and may be tried by such farmers as are not so far off as to make the carting too expensive. In proof of this, and to shew the way in which it has been used, I annex an extract of a letter I lately received from Ireland, containing an account of its application to the turnip crop :—

INGRAM FARM, NEAR LISBURN, IRELAND,
4th August 1845.

My employer, Mr Richardson, is a very extensive linen manufacturer and bleacher, and for some time past has occasionally been in the habit of applying the lime-waste of the works as manure. This year (before I came here) it was applied liberally to Swedish turnips, along with a little night soil. The soil is rather a stiff clay, not what we should consider in Scotland a *likely* soil for turnips, but has been thorough drained. For a considerable time, indeed until a week ago, the limed turnips were decidedly the worst in the field. The weather had been very dry, but since then we have had a plentiful supply of rain, and I now find that, in another day or so, they will be equal to the best, and have every appearance of being a very great crop. I may mention that, when thinning them out previous to the rains, such plants as were pushed out by the hoe, shewed an immense number of fibres, (much more than the turnips on the dunged part,) and all grasping a lump of the waste lime, evidently shewing that the plants were sucking and deriving nourishment from it, although, from the effects of the drought, they could not be so much benefited as if it had been showery weather.

Besides waste lime, there is a considerable quantity of waste leys daily run off into the Laggan ; these have not been as yet saved, but I intend getting it done, and making it up into a compost with earth.

I am about to make trial of muriate of lime, as a means of fixing the ammonia of stables and dung-hills. It is manufactured by a firm in England, and delivered in Liverpool at 45s. per ton. From the experiments which have been made with it, it appears to answer the purpose remarkably well, and is of great use in mixing with guano. It appears that it is made by a soda manufacturer, who, finding great complaints made against the injurious effects of the muriatic acid escaping by his chimneys, has contrived a chamber containing lime in a continual state of moisture, and into which the gas is conducted, instead of being, as formerly, carried up the chimney.

R. OLIPHANT PRINGLE,
Land-Steward.

This letter will probably draw the attention of farmers in the neighbourhood of bleach-fields to the possibility of using this waste lime with advantage and economy.

XVIII.—OF THE COMPOSITION OF OIL-CAKES.

The *exact* composition of oil-cakes being hitherto little understood, I took the opportunity afforded me by the receipt of several samples for examination, to cause them to be rigorously analysed, both in regard to their organic and to their inorganic parts. This analysis was performed by various methods, which I need not detail, and by several of my assistants. The analyses of the ash and the combustion for the purpose of determining the nitrogen, (or protein compounds,) were performed by Mr Fromberg—other parts of the examination were made by Mr Thomas.

1°. *Composition of the organic part* of two varieties of linseed-

cake and of one of gold of pleasure cake. These were found to consist respectively of—

	English Gold of Pleasure.	English Linseed Cake.	American Linseed Cake.
Water, ...	9.95	10.05	10.07
Mucilage, ...	35.08	39.10	36.25
Albumen and Gluten, . . .	25.50	22.14	22.26
Oil, ...	12.42	11.93	12.38
Husk, ...	10.16	9.53	12.69
Saline Matter (Ash) and Sand,	6.89	7.25	6.35
	100.	100.	100.

These analyses are interesting in several respects. They shew—

a. That the per-centage of the protein compounds, here called gluten and albumen, is nearly equal to what is contained in pease and beans, and that, therefore, for the production of milk for the cheese-dairy, and for laying on muscle, oil-cakes are as valuable as beans, pease, or clovers. This is a result somewhat unexpected, inasmuch as the value of oil-cakes in the feeding of stock has hitherto been supposed to depend very much upon their power of laying on fat: in other words, upon the per-centage of oil they contain.

b. The proportion of oil remaining in these cakes is greater than is naturally present in any species of grain or pulse usually cultivated as food for animals. Oats contain as a maximum about 7, and Indian corn about 9 per cent. of oil, but these cakes contain 12 per cent., and are, therefore, in their ability to supply fat to an animal, superior to any of our cultivated grains.

c. All the three cakes resemble each other in their general composition, and, no doubt, differences exist between different samples of the same cake equal to those which the above table exhibits, between the several samples of different kinds of cake. This is especially interesting in reference to the gold of pleasure cake recently introduced into the English market, which has a peculiar flavour, but is said to be relished by cattle, and which, according to the analysis, possesses feeding properties equal to those of the best English and American linseed cakes.*

It is difficult to say, as yet, in what form the protein compounds exist in these oil-cakes. That a portion of them is in the state

* I may here notice an analysis of the seed of gold of pleasure published by the patentee for making oil-cake from this seed, and purporting to be made by Dr Ryan. This analysis states the nitrogen in the seed at 12.27 per cent., equal to 77 per cent. of albumen, &c., and after the expression of the oil, the cake should contain upwards of 80 per cent. There is reason to think that the alleged result of Dr Ryan involves a large error.

of *soluble albumen* is shewn by rubbing the powdered cake in a mortar with successive portions of cold water, filtering, and then heating the dilute solution nearly to boiling, a portion of albumen coagulates, falls to the bottom, and may be collected. By boiling the insoluble residue in acetic acid, a portion of coagulated albumen is dissolved, and may also be collected by neutralizing the acid solution. Mr Thomas obtained in this way, from the three cakes in one trial, the following quantities of albumen—

	Soluble.	Coagulated.	Total.
English Linseed Cake, ...	3.69	3.08	6.77
American, ...	3.30	2.88	6.18
Gold of Pleasure, ...	3.75	2.92	6.67

The albumen thus obtained did not amount to more than about one-fourth of the weight of the protein compounds present in the cake. The rest must be in the state of casein, gluten, &c., or, perhaps, in that of a compound peculiar to these oily seeds. These compounds, however, must all be modified in the cake by the heat which is applied to the seed during the process of extracting the oil.

2°. *Composition of the ash or inorganic part* of the several kinds of cake.

These analyses were conducted by Mr Fromberg in the ordinary way, and I only insert their results. The ash consisted of—

	English Gold of Pleasure.	English Linseed Cake.	American Linseed Cake.
Alkaline Salts, ...	30.43	31.55	38.20
Phosphates of Lime & Magnesia,	40.56	47.67	56.26
Lime, ...	3.46	4.88	1.24
Magnesia, ...	0.49	1.51	trace
Silica, ...	13.65	10.81	4.04
Sand, ...	10.84	3.86	...
	99.43	100.28	99.74

Upon these analyses the following observations present themselves.

a. The ash of these oily seeds—in so far as we can judge of it from that of the cakes, which are seldom manufactured from perfectly clean seed—resembles that left by our grain-crops, in containing a large proportion of phosphates. In the gold of pleasure cake this proportion appears less than in the others, but this arises in part from its containing 11 per cent of sand and nearly 14 per cent. of silica, a portion of which may, in reality, have been derived from the sand which the cake contained, and which is very difficult to estimate exactly. The same may be said of the silica in the English linseed cake, and, in

fact, the pure lint and gold of pleasure cakes must be analysed from different localities before we can determine what proportion of silica the pure cakes *ought* to contain.

In the above analyses the proportion of magnesia in the state of phosphate was not determined, nor the phosphoric acid in the alkaline salts; the exact proportion of this acid contained in the ash cannot, therefore, be deduced from these analyses. We may safely estimate it, however, at one-third of the whole weight of the ash. In the ash left by our usually cultivated crops of grain, when free from husk, the phosphoric acid forms about one-half of the whole weight. A knowledge of these several proportions suggests the following very interesting practical observations:—

1°. These oil-cakes leave six per cent. of ash, of which one-third consists of phosphoric acid: 100 lbs. of oil-cake, therefore, contain 2 lbs. of phosphoric acid. On the other hand, our common kinds of corn—wheat, for example—leave only two per cent. of ash, of which one-half consists of phosphoric acid, or 100 lbs. of wheat contain 1 lb. of phosphoric acid. *Therefore*, for laying on *bone*, or for supplying the materials of bone to growing stock, *oil-cake is twice as valuable as wheat*, weight for weight, and *more than twice as valuable as oats or barley* which are covered with a husk.

2°. Again, the same reasoning shews us that, as grains of all kinds draw their phosphoric acid from the soil, these oily seeds will exhaust the soil of its phosphates to a much greater degree than our corn crops: 100 lbs. of linseed will carry off twice as much of them from the soil as 100 lbs. of wheat.

3°. But the same circumstance supplies us with an additional reason why the manure of *full-grown* store stock fed upon oil-cake is so much richer than that obtained by the use of any other kind of food. It is richer—

a. Because, as we have above seen, the proportion of the protein compounds (albumen, &c.) in the oil-cake is greater than the fattening animal can appropriate, and thus much of them passes off in a more or less changed state and is mixed with the dung.

b. The oil also is in larger proportion than can at times be laid on their bodies even by fattening stock, and this unquestionably contributes to the fertilizing quality of the manure.

c. But the full-grown animal appropriates scarcely any of the *phosphates*—the whole of these, therefore, which the animal consumes in its food, appears again in its dung. And, as we have above seen, the oil-cakes being richer in these phosphates, weight for weight, than any kind of corn we use for food, the dung thus made is also richer in these phosphates than that

which is obtained from animals fed upon almost any other kind of food.

I do not at present advert to other points of interest, to which the above analyses will naturally draw the attention of the intelligent farmer—such, for example, as the supposed exhausting nature of the flax crop, and the alleged economy of using lint *seed* in the feeding of cattle. These and other points I shall have occasion in subsequent articles to take into detailed consideration.

XIX.—CAN A SUBSTITUTE BE RECOMMENDED FOR OIL-CAKE IN THE FEEDING OF CATTLE?

This is a question which is interesting in many points of view, though I cannot yet fully answer it. It implies two things—*first*, can a compound of other kinds of food be made up which shall be as good for feeding cattle, and form as rich a manure, as oil-cake? and, *second*, can this mixture be sold at a cheaper rate than oil-cake? We may be able to fulfil the first condition—but, unless the mixture is cheaper than oil-cake, we can scarcely hope to supply its place to the farmer—we can never expect to supersede it.

When the Committee of the Agricultural Chemistry Association did me the honour, at the beginning of this year, to submit this question to my consideration, the chemical composition of oil-cake was unknown; and, therefore, there were not the means of determining how it would be possible to fulfil the first condition—to make a mixture which should be equally capable of all the useful applications which are now made of the natural oil-cake. It was chiefly with the view of supplying the data by which this practical question was to be resolved that I caused the oil-cakes, which form the subject of the preceding article, to be subjected to analysis in the laboratory. The results of the analyses above stated shew upon what circumstances the peculiarly valuable qualities of oil-cake depend, and enable us to say how far we can hope successfully to imitate it. Let us briefly consider these circumstances.

1°. The oil-cake contains from 22 to 25 per cent. of protein compounds, (albumen, gluten, &c.) In this respect the pea and the bean are the only seeds that approach to it—the pea containing about 24, and the bean sometimes as much as 28 per cent. of such protein compounds. The bean, therefore, is the only other vegetable food we possess which can be made the basis of an artificial imitation of the cake from oily seeds.

2°. The next peculiarity in the oil-cakes is the large proportion of fatty matter they still contain. In the best English and foreign cakes, the unextracted oil appears to amount to nearly

12 per cent. This also is greater than any other food usually given to our cattle contains. Oil or fat, in some cheap form or other, must, therefore, be added to any mixture which is to rival oil-cake. If, with 90 lbs. of beans, we could mix, grind up, or otherwise incorporate 80 lbs. of oil or fat, we should have a compound nearly equal, in all but one respect, to an equal weight of the cake from the natural seed. Thus 100 lbs. of English oil-cake and 100 lbs. of beans, so prepared, would consist respectively of—

	Linseed Cake.	Prepared Beans.
Starch, Sugar, and Gum or Mucilage,	39	40
Gluten, Albumen, &c.,	22	25
Fat,	12	12
Ash,	7	3
Water* and Husk,	20	20
	100	100

On comparing these two columns, we see that the mixed beans have the advantage in regard to starch and gluten, and are defective only as regards the inorganic matter or ash. Of this last the beans contain only one-half, and will, consequently, be deficient in alkaline matter and in phosphates, as compared with the oil-cakes.

The difference in composition between the ash of the bean and that of the oily seeds, so far as they have hitherto been analysed, does not appear to be very great, the main difference being that the beans contain more alkaline matter and the oily seeds more lime. An addition of 6 lbs. of ordinary *bone-meal*, recently ground, and in a fresh and sweet state, would supply the lack of lime and phosphates, and would make a mixture equivalent in chemical composition, and, therefore, I should hope, equal in fattening and other virtues, to an equal weight of oil-cake.

First Prescription.—Thus the proposed mixture would consist of—

Bean-meal,	90 lbs.
Oil or Fat,	10
Bone-meal,	6 lbs.
	106 lbs.

These would require to be mixed, ground, or boiled up together, and might be given as food either in a dry or a wet state. Or they may be made into a cake—which would keep for any length of time, by drenching the mixed powder with a weak solution of glue, (made by boiling bones in water,) and then compressing the whole into a mould.

The principle of this mixture being known, other modifications

* The proportion of this water would vary in different samples of beans.

of the above may be devised, but if formed of vegetable food, the bean or some other kind of pulse must form the basis of them all. The proper proportioning of the fat to the protein compounds is a matter of vital moment. In the relative proportions of these two classes of substances consists the main distinction between the bean and the oily seeds. The small quantity of oil it contains forms one of the chief reasons why the bean, though known to be valuable in feeding, when given in limited quantity, yet cannot be given with safety in very large proportion to the greater number of our domestic animals.

Second Prescription.—The principal difficulty attending the above prescription will be in procuring and mixing the fat with the bean-meal. But the same end may be attained in a different way. Fresh linseed, of good quality, contains upwards of 20 per cent. of oil. A mixture, therefore, of

Bruised Linseed, ...	40 lbs.
Bean-meal, ...	60
Bone-meal, ...	4

would contain of the several constituents which are essential to the value of the mixture *about*

Starch, ...	40 lbs.
Protein Compounds, . .	27
Fat, ...	11
Saline Matter, ...	7
Water and Husk, . . .	15
	100

This mixture approaches very nearly in composition to the original oil-cake. There seems, therefore, a very good *theoretical* reason for the practice now strongly recommended by many persons, of using a mixture of bruised linseed, or of linseed jelly, along with the other food given in the ordinary feeding of stock. The oil and saline matter of the linseed actually makes the starch and protein compounds of the rest of the food go farther.

I suppose it would be a very simple process, by the aid of a gentle heat, to compress into hard, durable, and tenacious cakes, the above mixture of linseed, crushed beans, and bone-meal.

Third Prescription.—But there is a third method of making a mixture of this kind. I do not pronounce with the same degree of confidence upon the following prescription, however, chiefly because our knowledge is still defective upon some points involved in it, but I insert it for the consideration of those who are interested in this matter, and for the purpose of its being submitted to experiment by any of our members.

I have already said that it is the protein compounds—those yielding nitrogen to the animal—which are especially abundant in the oil-cakes, and, therefore, difficult to supply in equal proportion, except by the use of a very limited number of vegetable substances. But there is an animal substance which might be obtained in comparatively large quantity, from which a compound capable of supplying nitrogen to the animal might be artificially made up with comparative ease. This substance is *gelatine* or *glue*. By boiling bones this is readily extracted, and by concentrating the solution and mixing with it the other ingredients of oil-cake, in a dry state, a compound or cake might be formed, which would probably feed well, and might be preserved for any length of time. With this gelatine we could mix the meal of any grain, or starch of any kind, selecting that which was cheapest and most easily obtained. The glue of commerce contains a variable quantity of water—sometimes not less than a third of its whole weight—were we to employ such glue, we might take in round numbers—

30 lbs. Glue equal to . .	dry Gelatine,	20 lbs.
72 ... Barley-meal equal to	Gelatine,	6 ...
	Starch,	40 ...
	Fat,	3 ...
10 ... of Oil or Fat, ...		10 ...
112 lbs.		

so that 1 cwt. of this mixture would, with the addition of 6 lbs. of bone-meal, be equivalent to 100 lbs. of oil-cake.

But the manufacturers of such an article as this would not use the glue of commerce; they would prepare their own jelly by boiling bones, and would save labour and fuel by adding the starch and fat during the concentration of their glue. The bones would also yield a certain quantity of oil, and would thus render it unnecessary to add so large a proportion of this necessary ingredient.

I have said that our knowledge is at present deficient upon some of the points which are involved in the supposed efficacy of the above admixture, and that I am by no means so confident in recommending the manufacture and use of this as of the other mixtures to the practical farmer. The point of uncertainty is this. The gelatine contains a larger proportion of nitrogen even than albumen or the other compounds of protein, and, therefore, may *possibly* be capable of nourishing the animal even more than these substances. But its true effect, when introduced into the stomach of animals, has not yet been fully established. It is not certainly known, for example, that the

gelatine will *readily* form the substance of muscle, because, before doing so, it must undergo a certain chemical change, which the digestive apparatus of the healthy animal may not be able, comfortably and with ease to itself, to effect. This, however, is only a supposition, supported by certain experiments made in unnatural conditions, and, therefore, by no means conclusive. From numerous considerations, I think it likely that such a mixture as the above will resemble oil-cake, in its feeding and other properties, and, therefore, I recommend it as worthy of a trial.

The *mechanical* question—how such mixtures could be most perfectly and cheaply made; and the *economical* question—as to the relative cost of these several mixtures, and of the oil-cakes they are intended to supersede, I delay at present to enter upon. Indeed every practical man can easily inquire into and answer these questions for himself.

REPORT on the IMPLEMENTS and MACHINES EXHIBITED at the HIGHLAND and AGRICULTURAL SOCIETY'S GENERAL SHOW, Held at DUMFRIES in 1845.

By Mr James Slight, Engineer, Curator of the Society's Models and Machines.

It is not without a feeling of diffidence and a strong sense of the onerous nature of the duty which the Directors of the Highland and Agricultural Society have, in this matter, confided to the author of this report, that he now comes before the society and the public, and particularly those individuals more directly interested—the exhibitors at the show. The Directors, by defining the duties and objects connected with this report, have, by so doing, rendered these duties, though not less onerous, at least more agreeable and easy of accomplishment. As for the objects of the report, it may be proper in the outset to state the leading points which the Directors have in view. From the great number of exhibitors, and the comparatively small number of premiums which could be offered, and seeing that, of necessity, some of the unsuccessful competitors would exhibit articles which, in quality, might fall but little short of those for which premiums would be awarded, the Directors justly considered that all parties might be benefited by the publication of a judicious report of the whole exhibition. Besides adverting, in such a report, to what might be found commendable in all deserving cases, it was in the instructions of the Directors to point out striking defects of construction or of principle, wherever such should occur; and the object of this was, that such criticisms might serve not only

as a corrective to those machinists whose works exhibit defects, but be useful as cautions to those who are more fortunate or better instructed. To render the report more intelligible, it has been thought advisable to insert the specification of the premium for each class of articles.

Relying on the indulgence of the Directors, and on that of the individuals whose works are to be noticed, for any omission or even mis-statement that may possibly occur, arising from the various other duties to which the reporter had to attend during the days of the show, he humbly proceeds to discharge the duties intrusted to him, which, to the extent that his limited space allows, he will endeavour to do with all fairness and impartiality.

Class I.

For the best collection of Agricultural Implements and Machines of any Description, manufactured by or under the superintendence of the exhibitor, just proportion of parts, workmanship, utility, and price being considered. Premium, Ten Sovereigns.

In this class only one exhibitor appeared, R. Gray & Sons, Uddingstone. The collection comprised 9 implements, viz. —3 ploughs, 1 subsoil-plough, 1 cart, 2 drill or subsoil pulverizers, 1 set draught-bars, 1 drill-plough ; and of these implements, eight of them competed also in other classes, the remaining one, therefore, falls only to be particularized under this head, viz.—

A set of two-horse draught-bars for equalizing the draught. This article exhibited no novelty, the construction being nothing more than the well-known shifting shakle, (or fulcrum,) which, by lengthening one arm of the lever, (the main bar,) and shortening the other, gives the means of accommodating the naturally unequal power of a heavy and a light horse when yoked in the plough or harrow as a pair.

As a collection, R. Gray & Sons' implements, though not numerous, exhibited in almost every case a highly commendable example of *workmanship*. Defects there were in some points in the proportioning of parts, and there were also errors in construction, to be afterwards noticed ; but, as a whole, the collection does much credit to the firm of Gray & Sons, as well as to the school in which the head of that firm originally obtained the rudiments of his mechanical education, the workshops of Wilkie of Uddingstone. There being no competition in this class, together with the reasons indicated above, the judges felt not warranted in giving the full premium offered, but awarded 5 sovereigns to Messrs Gray & Sons.

Class II.

For any new and useful Agricultural Implement or Machine, that has been satisfactorily tested in actual work, not previously exhibited in competition—a Premium of Five Sovereigns.

In this class there were ten entries, embracing 15 articles, most of which deserved notice.

Richard Colman of Colchester, Sussex, exhibited his patent expanding lever-harrows, in two sizes, his own invention, price £7 : 10s. and £8 : 10s. These harrows embody two essential points—1*st*, The principle of their expansion, which is based on a strictly geometrical principle—that a parallelogram, divided into any number of lesser parallelograms, by lines drawn parallel to two of its contiguous sides, will have these smaller, each exactly similar to the original figure; and whatever degree of obliquity may be given to the greater, each of the lesser will undergo the same change, preserving the exact similarity of figure. 2*d*, The harrows being supported on small wheels attached to levers, whereby any degree in depth of penetration by the tines is readily obtained at pleasure, by changing the position of the levers.

The first property is an important one as applied to the harrow, and the changeable nature of the parallelogram when not tied by a diagonal, as well as the constant similarity of its integral divisions, are very beautifully brought to bear in this improvement. By their means this harrow is capable not only of making every tine form a distinct line in the soil, like the best kinds of common harrow, but the distance between the whole of these lines can be varied with mathematical exactness, both as to equality one with another and to extent of variation. Thus, they will draw lines that shall be all four inches, or all one inch apart, or at any fractional part of the distance between these; and the construction being effected, the changes are produced by simply changing the place of a hook in a chain. We have few examples in agricultural machinery where a geometrical principle has been so happily applied, and applied too to one of the rudest of implements. The variation in depth of penetration seems also a considerable step in the perfecting of this harrow, that being a point in which all others are defective. An objection was made to the use of cast-iron in these harrows, but the inventor stated that he also makes them entirely of malleable iron. As there was no opportunity of testing these harrows in the field, it would be premature to pronounce upon their *practical* efficiency, though in principle they are in advance of all others. Under the circumstance also of these harrows being

patented, the judges, though approving, could not do more than award to Mr Colman a premium of 3 sovereigns.

Alexander Dean, Birmingham, entered his universal crusher for linseed, oats, beans, barley, pease, malt, &c., and his gorse or whin-crushing machine, but the former only came forward, and that not till after the judges had reported. It could not, therefore, compete, but is an article deserving notice here. This crushing machine is of an improved construction. The two rollers are each 18 inches long and 7 inches diameter; they are grooved in the longitudinal direction, with an obliquity of about 5°. The grooves are pitched at 8 in the inch, very shallow, and the ridge flattened on the top. This last quality admits of scrapers being applied to the rollers; hence they cannot become clogged, though the grain or seeds should be damp. The rollers revolve in opposite directions, the one making three revolutions for one of the other. The adjustment of the rollers is accomplished in a more perfect manner than usual, by a worm or screw-wheel fixed on each of the adjusting screws, and these are acted upon by a spindle carrying a worm or endless screw at each end. By these means the adjusting screws act always together, preventing the possibility of placing the rollers in closer contact at one end than the other. This method of adjustment is not new in itself, but has hitherto been applied to machinery of a higher order. This machine is altogether fitted up in a style superior to the ordinary construction of agricultural machinery, and does credit to Mr Deans, while it may also stand as an example for further attention, and care being bestowed upon this hitherto rather neglected branch of mechanism.

Robert Elliot, Hardgrave, Dumfriesshire, exhibited a hand stubble-rake, the invention of H. Smith & Co. of Stamford, price £2. This instrument is mounted on wheels, and furnished with a discharging lever. It appears much too fragile for its purpose, and while it is greatly inferior to the common horse-rake in construction and efficiency, its price is little inferior.

John Geddes, Cargen Bridge, Kirkcudbright, exhibited a drill-sowing machine for grain, recommended as requiring no toothed wheels to regulate the discharge of the seed—price £12. The judges awarded to Mr Geddes the premium of 5 sovereigns for the ingenuity displayed in the construction of this machine.

In this drill-sowing machine, which is a modification of the English lever drill, there is, as usual in all Mr Geddes' productions, a very considerable display of ingenuity and contrivance. In some points these are to the furtherance of the objects of the machine, in others they form defects. Thus, in the discharging apparatus, we have a reciprocating action for the discharge of the seed by means of a lengthened plate perforated and recipro-

cating over corresponding perforations in a fixed plate, the motion being produced by a circular revolving ratchet acting on one arm of a lever, the other being attached to the end of the slide. This is a very ingenious combination, but is inferior in point of simplicity, and is more liable to derangement than either the spoon wheels of the English drill, or the yet more simple, though perfectly effective, method of the Scotch broad-cast machine, by small toothed wheels, and which has been with complete success adapted both to the common and lever Scotch drills. The seed tubes which, in the English drill, are usually a series of tinplate funnels, are here formed of small trunks of thin deal, with two knee-joints in each, which allow the coulters to rise and fall, and at the same time afford on opportunity for the sower to see that the delivery is going regularly on. The principle of these tubes is good, but the material is somewhat objectionable. The coulters are arranged to sow at 6 inches apart, a distance that destroys one essential object of sowing grain in drill—that of cleaning the ground between the rows, and it appears by almost universal consent that 9 inches is the approved distance. Mr Geddes has very judiciously placed the coulters alternately in advance, which, in this close practice, will prevent their choking, an inconvenience that would certainly occur were they placed in one line in such near proximity. This machine is the first of its peculiar construction, and has been but little tried in the field, but its main features coincide with one that has been some years in successful use.

Two implements, by R. Gray & Sons, Uddingstone, Lanarkshire, whose object is similar, namely, the tillage between the rows of green-drilled crop, and are named subsoil pulverizers—these implements fall under the class of horse-hoes, but are of stronger construction than usual. Their object is to penetrate into and stir the subsoil between the rows of potatoes, turnips, &c.

James Kirkwood, Tranent, East Lothian, exhibited a revolving harrow for breaking and pulverizing land. This implement is held to be of considerable importance—it has been lately introduced from Norway, and first adopted on the Duke of Buccleuch's home-farm, Dalkeith Park; and Mr Kirkwood, with his usual alacrity, has made some improvments on the original. The implement is essentially a clod-breaker, lighter and cheaper than those made under Crosskill's patent, but will not be altogether so effective. It consists of an oblong frame of iron, mounted on four low wheels. Two axles pass across the frame, and on them are strung a number of star-like cast-iron spoke-wheels, each with 4, or in some cases 5, pointed arms or rays, about 7 or 8 inches long—they stand about 5 inches apart, while the

axles are *twice* or more the length of the rays from each other, and the star wheels are so arranged on the one axle as to fall intermediately with those of the other, thus producing a more uniform effect on the soil. This appears to be the original form of the machine, but Mr Kirkwood has added two or more grubber tines fixed in the same frame. A trial was made of this implement in the trial field, but the soil being of a light free texture, not at all adapted to the objects of the Norwegian harrow, its effects could not be appreciated. From the known importance of the implement, and being the first in this country to take up its manufacture, the judges awarded to Mr Kirkwood a premium of 3 sovereigns.

Norman Lockhart of Tarbrax, Lanarkshire, exhibited also a very excellent example of the Norwegian clod-breaker, made also after the original model, by Richard Stratten, Bristol. In principle and general construction it differed so little from the former as not to require further remark. The judges awarded to Mr Lockhart, for the introduction of this implement, 2 sovereigns.

A very handsomely finished five-fold ribbing grubber or plough was exhibited by Hugh Cowan, Corstorphine, Edinburgh. This implement has the general appearance of a grubber, but, in place of the simple tines, it is fitted with five small double mould-board-plough bodies. The arrangement of this implement is not new, the society having, on a former occasion, awarded a premium for a similar ribbing machine, but constructed of wood. The judges, therefore, though much pleased with the construction and finish of Mr Cowan's machine, could not do more than express their approbation, though aware also that it is giving every satisfaction in practice. The price of the implement is £5.

An unpretending, cheap, and simple mode of ventilating corn and hay stacks, was produced by Robert M'Turk of Hastings-hall, Dumfriesshire, and made by Robert Watt, Dumfries. The invention consists in forming skeleton cylinders, with very slight laths of wood, fixed upon iron hoops of about 8 inches in diameter. They may be made to any length, and are easily joined end to end, or turned in any direction within the stack, forming permanent air tunnels through it. For this invention the silver medal was awarded to Mr M'Turk.

Class III.

For any Design, Model, or Drawing of any new Machine or Implement.—The Gold or Silver Medal.

In this class the only objects of importance were a series of models from William Crosskill, Beverly, Yorkshire.

1*st*, Models of patent wheels and axles, in the making of which every known appliance of mechanical aid is adopted, to secure correctness of construction and expedition, with uniformity and neatness of finish.

2*d*, Improved cart, with self-acting tail-board or door, for discharging the contents of the loaded cart—a very ingenious contrivance, adapted to coup or tilt carts, in which the act of unlocking and tilting also opens the tail-board; but it seems to be one of those inventions that are in advance of their times, hence its adoption by farmers, in the present state of farm-machinery in Scotland, is doubtful.

3*d*, A one-horse cart, after the Scotch model, without anything remarkable except its very handsome finish.

4*th*, Iron liquid-manure cart. This is a model of a very complete and efficient machine. The distributer is believed to be particularly so—consisting of a trough with a serrated edge, over which is placed a sluice-board or plate, adjustable to any quantity of discharge.

5*th*, Read's patent subsoil pulverizer, made by Mr Crosskill. This instrument, like others of its kind, is, properly speaking, a furrow-grubber, intended to follow a common plough in the manner of subsoil-ploughing; but it differs from others of the same kind in being supported on four wheels. For this model the silver medal was awarded to Mr Crosskill.

Class IV.

For such useful Improvement in the Construction of the Subsoil-Plough as may be best suited to accomplish the main object of subsoil ploughing, viz.—moving, breaking, stirring, and effectually detaching the subsoil from its own substratum, without bringing it to the surface—the Premium of Seven Sovereigns.

In this class three exhibitors appeared, and a fourth entered in Class XII.

1*st*, By James Anderson, Howwood, Renfrewshire, and made by Andrew Carnduff, Howwood. This is one of those implements styled subsoil pulverizers, or furrow grubbers, having three swan-neck grubber tines only, in place of the share and feathers of the true subsoil-plough; and, as usual, it follows in the furrow of a common plough.

2*d*, By R. Gray & Sons, Uddingstone, a Smith's subsoil-plough, with proposed improvements. These consisted principally in the arrangement of the feathers or cutters; thus, in place of the usual sock feather a crescent-shaped cutter is attached to the body behind the sock. This cutter seems judiciously placed, but is misshapen, one-half nearly of its apparently cutting edge looking backward, as if placed for ornament rather than use. The usual ver-

tical cutter is, in like manner, out of shape, its proper duty being to cut that part of the subsoil into which the plough penetrates, seldom exceeding 8 inches, it is not required to rise higher than that; but in this improvement the feather rises in an obtuse arched form, to 12 or 14 inches. The implement in all other respects shewed a fine example of workmanship and judicious construction to secure strength. As an example of the latter, the two body bars were welded up solid with the beam.

In this class, during the trials, appeared also the two furrow-grubbers of Messrs Gray, and likewise a mole-plough convertible into a proper subsoil-plough, from John West, Lundie, Forfarshire.

In the trials of these implements in the field, it was observed that James Anderson's plough, drawn by two horses, penetrated to a depth of 9 inches below the sole of the preceding common plough furrow with a draught of 36 stone. The effect was the stirring up and mixing a portion of the subsoil with the upper soil, approaching to the effect of trenching, and the implement worked very satisfactorily.

Messrs Gray's subsoil plough was observed to work very heavily, and performed, in the opinion of the judges, less satisfactorily than those of the usual form of the Deanston plough. The furrow grubber or pulverizer of Messrs Gray, with three tines, indicated a draught of 24 stone, but the depth of penetration was only 6 inches; and though it seemed to move tolerably steady, its effects were deemed insufficient. The five tined drill grubber or pulverizer of the same firm was found to have the tines two wide set, which, by cutting on both sides beyond the proper width of the furrow, produced a heavier draught and less perfect work than the former.

J. West's plough of Class XIV. was tried in its form of a mole-plough, when, with a depth of $8\frac{1}{2}$ inches, it indicated a draught of 40 stone, and its effect at the surface was similar to that of the proper subsoil-plough, in not bringing up the subsoil. From the absence of Mr West at the time of the trials, the conversion of his plough into the subsoil form could not be effected; no trial, therefore, of it in that state could be made.

The judges, in considering this class of implements, found none deserving of the full premium, but awarded to James Anderson for his subsoil-plough or grubber a premium of 3 sovereigns, and to John West for his mole plough, that may be converted into a subsoil-plough, 3 sovereigns. This plough, although not entered as competing in this class, clearly commanded consideration along with those that were so entered, and for comparison also it became more convenient to consider it here.

It may be remarked, in reference to the entries in this class, that, of the implements tried under it, two only were strictly adapted to perform the requirements of the specification of

the premium. The others are a different variety of implements, not calculated to perform the requisites described; and here it may be proper to notice that Smith's subsoil-plough, as originally intended, effects its object without bringing the subsoil directly to the surface, which is of importance in many cases. The effects of the more recent variety of the implement, here and elsewhere styled subsoil-pulverizers, would produce deterioration in many cases, by bringing up the subsoil before being prepared for mixing with the true soil. In those cases where the subsoil is essentially of the same nature with the true, the latter will be improved by the direct mixing of a portion of the former with it; hence it should be kept in view that, while the subsoil plough may be used with safety in all cases, and with manifest advantage in almost all, the subsoil pulverizer can be used with advantage in those cases only where the subsoil is merely a continuation of the upper soil, but not in those where the subsoil is a poor moor-band.

Class V.

For any useful Improvement in the Construction of the Common Two-horse Plough, which has for its object the Lifting and Turning over the greatest quantity of the Soil in a given time, with the least resistance, and which produces at the same time a fair and efficient surface for exposure or for seed. Premium, Seven Sovereigns.

In this class eleven ploughs were entered, but after trials of those allotted for the trial field, and a careful examination of all that came forward to the show-ground, the judges found none that possessed any decided improvement either in construction or in effect. In consequence of this want of real improvement, the judges found that the proposed premium could not be awarded to any; while, from the workmanlike manner in which all were constructed, and in consideration of the cost incurred in bringing them to the Show, it was thought proper to award two sovereigns to each competitor, towards the defraying of his expenses.

The ploughs exhibited were chiefly after the Wilkie or Lanarkshire model, with less or more of variation from the original, and it is deserving of remark, that a preponderance of these variations were in the legthening of the mould-board.

Where all the implements were of excellent workmanship, and comparatively small difference in their forms, it was difficult to select for trial; but in the end, six out of the eleven were chosen. The trial-field was the same as for the subsoil ploughs, and was by no means favourable. It was an unequal lightish loam, and intersected by a broad band, in which the subsoil was

full of small boulders and gravel, coming near to the surface. such inequalities required great attention on the part of the judges to determine the average indication of the dynamometer for the draught, and, being a wheat stubble, was not calculated to show off fine ploughing. The same cause rendered impossible the preserving a standard depth of furrow, which would have made the comparisons more simple. The following table exhibits the results of the trials:—

Name.	No.	Draught per Stones Imp.	Depth of Furrow.	Breadth of Furrow.	Remarks.
			Inches.	Inches.	
W. Anderson, .	1	23	7	9	Lengthened Mould Board.
G. Campbell, .	2	25	7½	10	Do., Sole.
R. Crawford, .	3	22	6½	10	Common.
Gray & Sons, .	4	18	6	9	Common.
Do., . . .	~	19	6½	9	Obtuse body, not improved.
Do., . . .	~	26	7	9	Strong.
J. Kirkwood, .	5	26	8	10	East Lothian plough.
J. M'Carlie, . .	6	23	7	10	Common.

The ploughs exhibited, not only at the trial, but all in the class, were so well constructed, that it would be invidious to particularize, —some indeed were so highly finished as to appear as if in a holiday garb, and not in the usual solid plain style of finish which is alone wanted in all such articles. The makers, in all the examples, nevertheless, deserve the highest commendation for their exertions; and, from the number and workmanship here exhibited, it may very reasonably be inferred that the country is in no want of able artisans in this important branch of agricultural machinery.

Class VI.

For any useful Improvement in the Construction of Barn Fanners —a Premium of Five Sovereigns.

In this class two competitors only appeared. David Craig, Stewarton, Ayrshire, and Richard Wilson, Dumfries. The first exhibited a very fair example of fanners, but without anything new in their construction. A small fly-wheel is added, but this has been often tried before without establishing any permanent character. The second example is the ordinary warehouse blower or dusting fan, commonly used in granaries, being destitute of riddles, and having only one sieve. In the present case the feeding is effected by the common fluted roller in place of the shoe. No premium awarded.

Class VII.

For any useful Improvement in Farm-Carts and Wheels—a Premium of Five Sovereigns.

This class produced four examples of carts and wheels, all of excellent workmanship, doing great credit to the makers.

1. Robert Crawford exhibited a tilt or coup cart with a double lock, but in other respects differing little from an ordinary construction, except in finish. The side standards bolted on outside of the bed frame. The upper head bar laid flat ways and arched, bolted down to shelmonds, and finished with iron cross-head behind, the lock folding, double slotted, and keyed. Price £13. He also exhibited a dormant-bodied cart, finished in similar style. Price £12 : 12s.

2. Robert Gray & Sons, a coup-cart, also of excellent workmanship, finished very much in the style of the last, and having a proposed improvement in the formation of the axle. In this, the head or arm of the axle, instead of being turned conical, is flattened a little on three sides, so that, resting in the bush of the wheel, there are three lines of contact—one directly below, on which the load is borne, one before, which resists the force of traction, and one behind, ready to act in opposition to the last—these three lines are steeled and tempered. Except in the higher degree of finish, this is no new improvement, but a practice of very old date, originating probably in the want of means to produce a *turned* conical finish; this form was at one time held, and even now, with some artisans, is still held, indispensable to a good axle; but now that turning lathes are to be found in every considerable workshop, the method is being laid aside for the preferable, turned and tempered, conical or cylindrical arm. Price £11 : 11s.

4. Archibald Shankland, Thornhill, Dumfriesshire, exhibited a coup-cart which was also admired for the excellence of its workmanship, and though of a different construction from the former ones, had its parts judiciously arranged to produce strength. Each side was supported by three iron stays, being one more than usual; it was also furnished with a small hay frame and top sides. The locking of this cart is effected by a strong spring throwing a bar into a catch-hook on each side of the cart, a mode of locking which is becoming common, and is considered both convenient and secure. Price £10.

As a class, these four carts were perhaps the most perfect in the exhibition, and the judges awarded to Robert Crawford a premium of 3 soverigns, being especially for the double lock; and 3 sovereigns to Archibald Shankland, for the elevator and spring lock.

Class VIII.

For Improvements in the Thrashing-Machine—a Premium of Six Sovereigns.—In this class there were no entries.

Class IX.

For the most useful Improvement on the Construction of any of the Implements used in the Cultivation of the Turnip and Potato crops. Premium Five Sovereigns.

In this class 22 articles were entered by 18 exhibitors; but as many of them were implements already approved and well known, it is unnecessary to particularize such. The first to notice in the list is a turnip drill, made by John Affleck & Co., Palmerston, but invented by John Wightman, Holywood, a very compact and ingeniously constructed machine, sowing two drills at once. The frame-work of it is principally of cast-iron, as are also the seed-boxes; and the distribution of the seed is effected on the principle so generally adopted from the broad-cast machine. It has also the usual convenience of self-adjusting rollers, and the price is very moderate, £4 : 10s. The judges awarded a premium of 3 sovereigns, to be divided between the maker and inventor.

A turnip-sowing machine was exhibited by John Geddes, Cargen Bridge, Kirkcudbright, being an improvement on that for which he carried a premium at Berwick, and which appears also to have been the model for the preceding machine which has been improved by Wightman. Price £3 : 10s.

Richard Wilson, Dumfries, produced a turnip drill on the same or similar principles as the two former, but apparently got up with less care. Price £3 : 10s.

Thomas Inglis, West Linton, exhibited a double drill-paring plough, of very good workmanship, but possessing no improvement on that for which he got a premium at Edinburgh. It may be remarked that few double implements of the cultivating kind seem to obtain favour in Scottish farming; nevertheless several of them appeared on this occasion.

William Smith, Lochthorn, Dumfries, produced a very commendable selection of implements, consisting of, 1*st*, a double-drill plough, with two sets of scufflers, price £5—2*d*, a drill grubber, on the principle of Finlayson's self-cleaning implements, having swan-neck tines *bolted* upon the frame, price £4—3*d*, a common double mould-board or drill-plough, with gauges or markers to measure off the drills, price £4—and, 4*th*, a pair of saddle or potato drill-harrows, price £1 : 10s. These implements, without any pretension to unnecessary high finish, were all very substantially made, and, of course, usefully so, which is the state in which all such exhibitions should be. As a small collection of useful

implements, the judges awarded to Mr Smith a premium of 2 sovereigns.

Of the double implements, one was shewn by John B. Stainton, Milton, near Kendal, a double or twin-plough for green-drill crop, price £9 : 10s. It consisted of a four-sided frame, jointed at each angle, and attached to and jointed by the middle of the back and front bars to the beam. To each side-bar of this frame is attached a small plough body, with share and mould-board standing right and left, the mould-boards being towards each other. To the front bar is affixed a toothed semicircle concentric with the middle joint of the bar upon the beam, and this segment being moved by a pinion and handle, the side-bars of the frame preserving their parallelism, are brought nearer to or recede from each other, as the rhomboid is made more or less oblique. The hind bar of the frame has a plain quadrant or a semicircle fixed to it, and by means of a pinching screw it is clamped to the beam, thus retaining the two plough bodies at the required distances. For the good workmanship and mechanical arrangement of this implement, the judges awarded to Mr Stainton the society's silver medal.

John West, Lundie, Forfarshire, again brought forward his potato-lifting plough, with some improvements since a former exhibition. The leading principle continues the same, being the body of a common plough, with a wheel placed at the heel, to give motion, through the medium of a pair of small bevelled wheels, to a short horizontal shaft, carrying three or four flat iron blades or hoes about 4 inches broad. These, as they revolve at right angles to the path of the plough, through the potato-drill, break down and spread the slice of earth which the body of the plough progressively raises containing the tubers. The slice being thus broken down, the tubers are exposed and more easily collected. As will very readily occur on a consideration of the motion and effect of these revolving hoes, the apparatus is very liable to choke from the entanglement of the potato haulms with the hoes ; and even though the haulms have been previously cut off and removed, the liability to get choked up still remains, from the roots and fibres existing in the soil. Mr West is deserving of great commendation for his ingenious and excellent workmanship, in this as well as in other articles of his manufacture ; but it were, perhaps, better for him to exercise his skill on something more promising than this mode of potato-raising.

Class X.

For the most useful Improvement in any of the Utensils or Machines used in Dairy Husbandry—a Premium of Five Sovereigns.

In this class a considerable assortment of utensils was exhibited.

1. David Craig, Stewarton, Ayrshire, a horse-churn, differing in some points, which he conceives to be of importance, from the common Lanarkshire churn, as requiring less power and less time for the performance of the operation. It does not appear that the changes in the arrangement of parts, as here introduced, can produce any marked improvement or advantage. The individual parts, and the number of these, remain nearly the same as in the old arrangement, difference in position being the principal change; but, in justice to Mr Craig, it must be observed, that the work is very well executed, and the price, £14, very moderate when the quality of workmanship and substantial construction are considered.

2. A cheese-press by Robert Crawford, Uddingstone, exhibited nothing different from ordinary lever cheese-presses, but its price, £2, is very moderate. The workmanship does not come up to Mr Crawford's usual style.

3. A curd-cutter, by Robert Miller, Balgray, Lockerby, was approved of, and the silver medal awarded. This simple machine consists of a hopper, or box, 14 inches deep, 18 inches wide at top, and 5 inches at bottom, the length being 14 inches. On one side of the box is placed two rows of 31 knives or cutters. In the one row they are 1 inch long, in the other $3\frac{1}{2}$ inches. A roller or stock, 3 inches diameter, is fitted to turn in the bottom of the hopper, and is armed with three rows each of 32 cutters, placed spirally on the surface of the roller, falling intermediate with those in the hopper. The roller thus armed is turned by the hand within the hopper, with a velocity double of the hand, by means of a wheel and pinion. With this machine a quantity of curd, the produce of 30 or 40 cows, can be cut or broken in four minutes. The price is £1 : 10s.

4. Richard Robertson of Lisburn, Antrim county, Ireland, exhibited a variety of dairy utensils, chiefly churns, made by him after the registered invention of John Rowan and Sons, Ballyclare. They are on the principle of the box-churn, in which the cistern is stationary, and the plunger revolves, with examples also in which the milk or cream is surrounded by a case to contain hot or cold water, as the temperature may require. According to capacity these churns are worked either by hand or by power, and their price ranges from £2 : 5s. to £9 : 10s.

Mr Robertson's milk ripeners are vessels in the form of a deep pail, made of tinplate or other metal, and cased in the same, or in wood, forming a narrow chamber, surrounding the milk, and which is filled with water of a temperature suited to the intended expedition of the process of this artificial ripening. Price 14s. to 18s. The judges awarded 5 sovereigns for the churns, to be divided equally between the maker and inventor.

Class XI.

To the implement maker who shall have successfully introduced into Scotland, of his own manufacture, any Machine or Implement that is generally approved in the practice of agriculture in England or elsewhere, or a modification of the same, and which has hitherto been but little known or employed in Scotland. Premium Five Sovereigns.

In this class William Crosskill, Beverly, Yorkshire, exhibited his well-known clod-crusher, for which a premium was awarded at the meeting at Glasgow in 1844. Its merits are now so well known as to render description here unnecessary.

Richard Robertson, Lisburn, Ireland, exhibited a portable steaming apparatus for preparing food for cattle, horses, &c., with which the judges were so well satisfied, that the full premium of 5 sovereigns was awarded to Mr Robertson, and the silver medal to Mr Jennings, New York, as part inventor. The apparatus here exhibited is of a portable nature, in so far as it may be set down anywhere, and without brick or stone work. The boiler is of the well-known construction, long since occasionally applied, as the conical upright boiler. It consists of an outer and inner shell, the former of which may be cylindrical; the water is contained in the space between the two shells, which is closed at top and bottom, while the interior cone is open at both; the bottom with grate bars forming the furnace, and from that upward the chimney, terminating in an iron funnel, around which, and at a proper height, is fixed a cistern of water. The water becomes partially heated by the funnel passing through it, and in this state is taken into the boiler as required, in the usual way, by the feeding apparatus. The cooking vessels are placed around the boiler, and in connexion with the steam-pipe, the usual appliances of stop-cocks and couplings being employed for connecting the vessels with the steam-pipe. The price varies with the extent of the apparatus from £8 to £21. For small establishments this apparatus seems very well adapted; but its advantages for those of great extent are not so obvious.

Class XII.

For a Weighing-Machine adapted to general Farm purposes. Premium Five Sovereigns.

In this class there were no entries.

Class XIII.

For any improved Tile-Pipe or other invention for securing the Run of Water in Drains, possessing the advantages of cheapness and durability, combined with efficiency. Premium Ten Sovereigns.

1. Robert Beart, of Godmanchester, Huntingdonshire, exhi-

bited in this class specimens of a mode of securing the continuity of the conduit formed in a drain with tile-pipes, by a very simple yet very effective expedient. In the ends of each tile a simple square notch or indentation is formed, not exceeding half an inch in the length and one-fourth inch in width. When the pipes are being laid in the drain, a little wooden dowel, one inch in length, is inserted into the notch of the pipe already laid, which will thus project half an inch beyond the end of the pipe. The next pipe is brought to have its notch coinciding with the dowel in the first; it is then pushed up till the projecting part of the dowel passes into its notch, which connects the two, and effectually prevents the one swerving from the line of the other. This being repeated with every tile laid, and the earth filled in, the conduit will be continuous and unobstructed. It is of no moment how soon the wood may decay, as the earth is no sooner filled in than all displacement of the pipes is prevented, although the dowel were to suffer immediate destruction.

Specimens of tiles and soles of excellent quality were exhibited by Robert Boyle, Ayr; Thomas Chalmers, Dalbettie; Thomas Thorburn, Ryedale, Kirkcudbright; and John Henry Charnock, Wakefield, Yorkshire.

Mr Smith, late of Deanston, produced an interesting specimen of drain-pipe, manufactured from peat-moss, very perfect in its fabrication, and having its ends formed upon Mr Smith's patent mode of joining drain-pipes, the tri-lobate junction. It is to be regreted that Mr Smith has not furnished further information on this interesting subject, and all that can be said at present is, that, from the appearance of the specimen, the peat must have undergone a process of milling or trituration previous to moulding into the form exhibited. From the known durability of dried peat-moss, and the degree of perfection observable in the specimen, compared with peat-tiles, made from the moss as it exists, a great inducement is held out for the adoption of such peat drain-pipes in those districts where the material is abundant, provided the article can be produced at a moderate expense, but on this point information is wanting.

Class XIV.

For approved patented articles, and articles not coming within the range of any of the foregoing classes.

John Ainslie, Alperton, Middlesex, exhibited his drain-tile machine in operation, which gave great satisfaction, and received the award of 5 sovereigns or the medium gold medal. This new patent machine is a modification of Mr Ainslie's original patent, and is remarkable for its simplicity. A pair of cast-iron cylindrical rollers take the clay from a feeding web, and by simple adhesion it passes between them into a small chamber bounded

by a die-plate, in which is cut an orifice forming an exact transverse section of the tile or pipe to be made by it. As the clay is forced into the chamber by the revolution of the rollers, it passes out continuously at a proportionate rate through the die-plate, in one or more lines of perfectly formed pipe or tile, which, from thus taking the permanent form at the instant of ejection, are perfectly solid and free of fissures. These are first received upon an endless travelling web, which carries the ejected pipe or tile along with it; the turning of the rollers gives motion to the web, and at the same time to the cutting apparatus, which is ingeniously contrived, by means of a wire travelling in an orbit, to cut off the tiles at the desired length, while the machine and the tiles continue their motion unabated. The machine is worked by hand, and three men will produce 6,000 ordinary-sized tiles in 10 hours. The price is £30.

Mr Ainslie also exhibited plans of a patented mode of constructing a drying shed or chamber, wherein, by artificial heat, he expects to be able to manufacture tiles throughout the whole year.

The Ayrshire double-acting tile machine of Boyle & Young, Ayr, was also exhibited in operation; and, from the expedition and excellence of its produce, elicited great interest. In construction it is the Tweeddale patent machine, with very important improvements by Messrs Boyle & Young. The chief improvements are its sending out continuously two lines of tiles at once, completing both, with the same degree of precision that one line is done by the original machine, and, farther, by an ingenious and simple mode of cutting by the aid of the hand without stopping any of the motions. When in full operation, this machine, with four men, produces 8,000 tiles in ten hours. Where the clay is deficient in tenacity, all the machines acting on this principle—bending the tile into shape from a flat cake—are apt to produce tiles fissured or imperfect in the back; but in the present case the tiles produced were perfect. The price is £30. From the satisfactory manner in which this machine worked, the judges awarded the medium gold medal or 5 sovereigns for the improvement.

John Henry Charnock, Wakefield, Yorkshire, exhibited in operation his economic drain-tile and pipe-machine, price £20. This machine, which is one of the best of the intermittent kind, consists of two oblong rectangular chambers, to which are fitted two square pistons, acted upon alternately by a set of cranks and wheel-work, the same cranks being also adapted to open and shut alternately a sliding cover to each chamber, and those arrangements are adjusted to act in the following manner:—When a piston is withdrawn, the cover of its chamber is at the same time withdrawn; when the feeder throws a lump of clay into the chamber, the cover is immediately shut, and as the

piston advances, the clay is ejected through the orifice of a die-plate, as in Ainslie's machine. While this is going on, the piston and cover of the adjoining chamber have been withdrawn, and a lump of clay introduced, when the same operation as in the first is repeated, and this goes on alternately. If the lump of clay in the chamber has been insufficient to eject a full-length tile, what has been protruded remains uncut till the next charge, when its ejection completes the tile. The cutting is performed by a light iron bow and wire, connected by a joint with the *horsing* apparatus, when the horse is put under the tile or pipe, and pushed forward to its shoulder, the bow is pressed down with the left hand till the wire has passed quite through the tile. By this mode of cutting, the ends of the tile have a slight curvature, which is no impediment. This machine, with three men, produces 4,000 solid and well-formed tiles in ten hours. The judges were so well satisfied with the machine, and also with its moderate price, that they awarded a premium of 3 sovereigns.

The Garnkirk Coal Company exhibited a large collection of specimens of their fire-clay manufacture, in copies of antique vases, balustrades, elegant chimney terminations, and water-pipes—the last article being the invention of Mr James Murray of that Company. The examples from the antique in this collection are deserving of high commendation; as copies and specimens of art, they are far beyond what could be imagined as the produce of a brick-field, and their handsome finish testifies that artists of no mean character are employed in their fabrication. These articles are perfectly durable, and their cheapness puts it in the power of any person of taste to place around him copies of such of those examples of ancient art as his means may command.

An instrument called an American cradle-scythe was exhibited by Thomas Hodgson, Easton, Cumberland, which we cannot pass over without pointing out the mistaken ideas under which it had been constructed. The *cradle* seemed rather intended as a fence to retain sheep than to collect corn. It extended very nearly the entire length of the scythe-blade, and is by no means a light fabric. To wield a scythe mounted as this was, would be a punishment to a strong man. It ought to be generally known that the teeth of the cradle in a corn-scythe serve no good purpose beyond 12 inches in length from the heel of the scythe-blade.

F. M'Neill & Co., Lamb's Buildings, Bunhill Row, London, exhibited specimens of their patent asphalted felt for roofing, and dry hair felt, for forming a nonconducting medium where it is desirable to retain heat, such as steam-engine boilers, agricultural steaming apparatus, and the like. The roofing felt is an article much deserving of recommendation for all temporary erections, or even for those of a more permanent character. Its lightness enables the carpenter to construct his roof with a sav-

ing of at least half the usual materials. The price of this felt is one penny per square foot. The dry hair felt is particularly well adapted for deadening sound in any situation.

Richard Robertson of Lisburn exhibited in this class a patent cart axle, invented by John Rowan and Sons, Ballyclare, Antrim. The peculiarity of this axle is, a nest of antifriction cylinders, each equal in length to the arm of the axle, and revolving on a small axle of its own, set in a ring at each end. The invention is not new, and there is reason to fear, from former experience, that it will never be found suitable in practice.

A set of the iron-trussed swing-trees of James Slight, Edinburgh, for which a medal was awarded at the meeting at Dundee, in 1843, was exhibited, price 16s.; as also his Regnier's dynamometer, which, from its extreme simplicity, is considered by many to be preferable to those of greater complication and expense. The price is £3 : 15s.

The exhibition of cart, plough, and gig harness, together with gentlemen's and ladies' riding-saddles and bridles, by John Weir, Dumfries, was remarkable for the excellence of the workmanship and moderation of price. In consideration of which the judges awarded the society's silver medal to Mr Weir.

W. and C. Young, Edinburgh, brought forward their usual exhibition of useful and ornamental iron work, consisting of a numerous assortment of gates, hurdles, and light ornamental trellis-work, &c., the whole of which were highly commended. In an especial manner the judges were pleased with their portable iron sheep-rack, and awarded for it the society's silver medal to Messrs Young.

A collection of implements from the home farm of Marmaduke C. Maxwell, Esquire of Terregles, and made by Joseph Scurrah, Crakehall, Yorkshire, was shewn in this class. It consisted of the following articles :—

A horse-rake, on Grant's patent construction.

A grubber, partaking of the construction of Wilkie's in the frame-work and elevating apparatus, and of Earl Ducie's, in having the tines armed with cast-iron points of different shapes.

A five-tined drill-grubber, of a usual construction, and a set of S harrows.

These implements have been well tested during several seasons, and been uniformly found to answer their different purposes in the most satisfactory manner; the S harrows having in particular, been found to give the fullest satisfaction.

A novelty in the shape of a very humble but useful article, in the economy of Indian humble life, a *Pawn Goondie*, or leaf blanket, presented by Dr George Buist of Bombay. The *Pawn Goondie* is a rude weather-shield used by out-of-door labourers in India, to protect them from the rain. In its primi-

tive form it is a light frame of wicker-work, covered over with leaves, and has exactly the shape of the bow half of a small boat cut off. It is worn resting on the head and shoulders, and descends below the middle. Dr Buist recommends its adoption in this country as a very cheap *over coat* for labourers, especially those whose employment is stationary, such as stone-breakers, well-sinkers, &c.; and he proposes, in place of leaves, to use oiled linen cloth, of which material the one exhibited was constructed at an expense of about 2s.

Of this show of implements it may be said generally that it presented but little of novelty or of invention, but this should be no cause of surprise in a country that holds itself already in an advanced stage towards perfection in its agricultural economy, and in which there is consequently less encouragement given by the practical agriculturist to the exercise of the inventive faculties of its agricultural machinists. The agriculturist sees no great necessity for change in the form and structure of his implements and machines, and, satisfied with existing forms, makes efforts only to procure them at the lowest possible price. The machinist, from the great competition and consequent lowness of price of the articles he manufactures, cannot do more than procure a bare subsistence from his exertions. In this state he feels not the will nor has he the means whereby to make further efforts, especially in the field of invention, which always and insensibly leads to an expenditure which the position of such a man does not warrant. Seeing thus but faint hopes of encouragement from the quarter to which he naturally looks for aid, he settles down and plods on in the old beaten track, making, if any, but feeble attempts at improvement, much less original invention. It is notorious, also, that if an agricultural machinist makes a step in the march of improvement, his invention is no sooner promulgated than it is snatched from him, not only by his neighbours, but through those very means that are held out to him as for his benefit—it is spread all over the country, the inventor deriving little or no benefit from his skill thus exerted.

Notwithstanding these untoward circumstances for the agricultural machinist, it is pleasant to observe the altered state of these shows of implements. Seven years ago, at Dumfries, the exhibition consisted of perhaps eight or ten articles in that department. At the late show there were 89 entries, embracing considerably upwards of 140 articles, most of which were deserving of commendation for excellence of workmanship, and many for judicious construction. For this branch of the society's shows, however, it has not as yet been possible to devote a sum for premiums at all corresponding to its interest and value, or sufficient to mark, in an adequate degree, the society's sense of the merits of the exhibitors. But it is hoped it may be possible to extend, in

future shows, the amount of premiums for this important branch, and to take means, in the manner now for the first time attempted, of bringing the merits of the various implements and machines still more prominently before the public.

ON THE MINES, MINERALS, AND GEOLOGY OF WEST LOTHIAN.

By Charles Forsyth, Esq., Advocate.

[Premium—Twenty Sovereigns.]

In making a geological examination of a district such as that of West Lothian, where the minerals consist exclusively of those belonging to the coal formation and of trap rocks, it is necessary, in order to obtain such information as shall be valuable in a practical and, indeed, in a purely scientific point of view, not only that a strict inquiry should be made into the nature and peculiarities of the strata and rocks of the district, according to the method usually adopted by geologists, but also that an examination and inquiry should be made into its mining operations. It is to the practical man alone that the most valuable facts are known as to the real nature of these strata; for it is to him that their peculiarities are really important, and it is he alone who possesses the means and opportunity of tracing these peculiarities, and following them out beyond a very limited extent. It is not the less true that it is the scientific observer alone who can take an extended view of the subject generally, trace out causes, draw conclusions from facts thus obtained, and enter into a strict examination of the component parts and mineralogical character of these strata. But as it is the province of the miner to make himself acquainted with certain rules usually followed in conducting mining operations, it will indeed almost invariably be found that he possesses a knowledge of important facts of the greatest value to the scientific observer.

In describing the mining operations, it has been the author's endeavour to convey such practical information as he has had it in his power to obtain, and in such detail as appeared to him of importance. In regard to the plans and drawings necessary to illustrate the subject generally, the course preferred has been to give a general geological map of the county, and separate plans of the various mining operations where it has been considered desirable to do so, on account of their extent or the peculiarities attending them.* In regard to the connexion between the soils of the district and the subjacent minerals, and their influence upon agriculture, no general rule can be stated, as this

* It is considered unnecessary to publish the sections and voluminous details of the coal measures furnished to the Society by the Author.—Ed.

depends almost entirely on the varied local peculiarities of the coal strata, but more especially of the alluvial and diluvial deposits which overlie them, and as, from the peculiar nature of the trap rocks, little can be said as to the soils connected with them, from the exposed and often precipitous nature of the districts which they compose; but it may be stated generally, that, in localities where the soil is formed merely by the disintegration of the coal measures, it is almost invariably found to be unproductive.

Alluvial and Diluvial Deposits.

The great mass of the deposits which cover the coal measures of this district are composed of beds of clay, gravel, sand, &c., which contain boulders composed of minerals similar to those which occur in the district. And although these diluvial deposits have evidently been influenced by powerful currents, it does not appear that the materials of which they are composed have been transported from any considerable distance. They are found in some localities to be of great depth, in some instances occurring in the form of rounded eminences, at others in isolated mounds, as in the neighbourhood of Bathgate, where they are composed chiefly of gravel, and are called *inches;* but more generally occupying low-lying positions. Thus, on the Avon, Breich, and Almond waters, which form the boundaries of the county, beds of earthy clay and gravel are found sometimes to the depth of 50 or 60 feet. Alluvial deposits also occur, formed by the various waters in the low grounds which they traverse, and which often, as in the Breich and Almond waters, contain trunks of large trees embedded in them. The deposit of mud usually found in large estuaries, from the water of the various streams which flow into them, is found on the northern boundary of this county. There exist on the shore of the Forth, near Borrowstownness, 2,000 acres of such deposit, apparently capable of being enclosed in the manner adopted adjacent to the river Tay, whereby a tract now waste, of no value, and which is covered by every flood-tide, might be added to the productive lands of the county.

The only other substance of this nature of any importance is peat, which occurs in some localities to a considerable extent. The peat-mosses of this district are in general what are termed flow-mosses, and appear to have been formed by great forests, which seem at one time to have occupied a considerable extent of this part of Scotland. In almost all of them trees are found embedded, and the roots in many cases appear as if in the position in which the tree stood when growing, the peat having gradually increased, and covered up these roots to a considerable depth. The bones of a large kind of deer were lately found in a moss at Boghead, near Bathgate. These mosses are in some instances

of considerable depth, being in many cases from 30 to 40 feet. The bottom of them is usually composed of clay of a bluish-white colour. The mosses of this county are gradually diminishing in extent, in consequence of the large portions of them which have been brought into a state of cultivation or planted. One very important matter connected with this branch of the present subject is that of draining. In a district where coal measures occur, the use of drains is attended with many and great advantages, in consequence of the retentive nature which usually characterises the diluvial deposits which overlie them, and more especially from the very injurious effect which is produced in consequence of the water which issues from the coal strata being impregnated with iron. But although the evil be great, the remedy, if sought for, will usually be found at hand, as these coal measures themselves almost invariably contain materials well suited for counteracting these evils, when used for making drains. Thus, in many parts of West Lothian, shale is quarried to a considerable extent, for the purpose of making drains, and is well suited for that object, as it is easily worked, and is of a very durable nature, when covered up and removed from the influence of the atmosphere. Clay is also almost invariably found in such districts well suited for making drain tiles. Thus, in the neighbourhood of Bathgate, clay which is used for that purpose is found at Inchcorse, below a few feet of moss, and diluvial clay is also used about a mile north-west from Bathgate, and at Blackness, where there is an extensive brick and tile work. Clay is also generally found in coal-pits, of a nature well adapted for making bricks and tiles. Gravel from the beds of streams is also often employed in this district, and is found exceedingly well suited for carrying off water impregnated with iron.

From the peculiar position of the coal-fields of this county, occupying as they do the intermediate spaces between the two great coal-fields of Edinburgh and Glasgow, and from the irregular position in which the strata in many instances occur, it is necessarily a matter of considerable difficulty to trace out the relation which they bear to each other. The mining operations have indeed been carried on to a sufficient extent to prove that the district contains minerals which will yet afford an extensive field for enterprising individuals, but these have not been carried on to such an extent as to furnish data by which the exact relative position of the strata can be traced throughout the district generally. In addition to the journals of the pits, journals of borings in various places are given, wherever these appeared to be valuable, as pointing out the nature of the strata at the various places in which they have been made. In regard to the various beds of sandstone, shale, clay-stone, &c., of the coal formation, little requires to be said, as those of this district have few or no

peculiarities attending them, and vary so much in their extent and position, that no fixed rules can be formed as to their occurrence, or conclusions drawn from the relative positions in which they are found, as these beds, when traced to any considerable distance, are often found to pass into others of a totally different character, or to disappear altogether. This variation in the strata is found also to occur to a considerable extent in the beds of coal.

The coal formation of this district does not consist of one continuous series of beds, but of various series, more or less connected with each other. The most extensive of these is that which occupies the south-western part of the county, and consists of the Bonhar coal-field, the Crofthead or slaty-band ironstone field, and the various beds of coal found in the neighbourhood of Bathgate, Blackburn, &c. The next series is the Borrowstownness coal-field, situated on the north-western extremity. And the next consists of various basins of coal which occupy the eastern portion of the county.

Bonhar Coal-field.

The first coal-field which occurs on the western limit of the county is the Greenrig, or Polkemmet Bonhar coal-field, situated in the parish of Whitburn. This coal belongs to the Glasgow field, and comes under that class of coal which is termed Lady Anne coal. It appears to be quite detached from the rest of the coal in West Lothian, and has not been found in any other place within it. This field is kept clear by a day level, which runs to the north to near the Almond Water. The present pit, which is worked by a common or atmospheric engine of 4½-horse power, is 19 fathoms 5 feet deep. There are a number of pits which have been used at former times, varying from 14 to 19 fathoms in depth, and there is also a stair-pit by which the men enter the workings. It is worked stoop and room, the roof being too high and too brittle to admit of its being worked in the long-wall or Shropshire manner. The present working seam which is a splint, or "back-on-edge" coal of the best quality, is from 4½ to 5 feet thick, and dips north-west 1 foot in 12. There are two seams of coal below the one at present worked. These were found by Mr Geddes, when boring to the east of the pits, and were also found on the south; and there is also a seam of parrot coal, with rough coal below it, which is crossed in the day level. This field crops out at a short distance to the east of the pits. It lies between two great faults, which are usually termed dykes, one on the north of the field running south-east, which is shewn in the accompanying plan, and throws in the coal to the south; and the other on the south, coming near the south-west corner of the field. This fault runs parallel to the Polkemmet north fault or

main dyke, and cuts off the Duke of Hamilton's coal on the south and Lady Torphichen's coal on the west. There are also a number of slips or hitches down to the south, which chiefly run in directions nearly parallel to the main faults. The coal is found to rise a little before coming to these hitches, but falls again to the same amount immediately at them. There is usually bad air near these slips or hitches, but the air is not so bad near the larger faults. This arises from the edges of the fracture in small slips being somewhat open, and partly filled with black coaly and sometimes argillaceous substances, which by the miners is termed the *vise*, and which usually forms the guide or trace by which to discover whether the coal has been thrown up or down, whereas in large slips the edges or walls at the line of fracture are in much closer contact. These openings in the vises of the small slips, by which the foul air enters the workings, are sometimes from 1 to 1½ inches wide. There is clay in the under part of what the workmen call the "dogger-band" and in the bed below the coal, which would be well suited for making bricks. There is a good field of coal belonging to the Duke of Hamilton on the south-side of the Bonhar field, which is unwrought.

Shotts Coal-field.

The first coal found on the south-west extremity of the county is the Shotts coal. On the Falla Burn, a short way north from Fauldhouse village, the entrance to an ingoing eye is seen, by which the Shotts lower or stinking coal (so called from the quantity of sulphur which it contains) was worked about ten years ago. Between this place and Fauldhouse village four or five smaller seams of coal are seen cropping out on the sides of the Falla Burn, which are the lowest seams found next to the Crofthead coal, or coal of the slaty black-band series. There are a number of ingoing eyes seen on both sides of the burn at this place, but at what time these were worked is not known. The freestone rock above the lower coal is next seen, about 40 feet above which the Shotts main coal is seen, and above which the Shotts ironstone is found. The Shotts main coal was here worked at the Smithy Haugh, about 400 yards up the burn from Fauldhouse village, about twenty years ago, having a pump worked by a water wheel for clearing the workings to the dip. The coal was worked along with the ironstone, which is in the *Following*, or soft stratum which lies immediately above the coal. Still further up this burn, there is a good freestone quarry, called Falla Hills Quarry; the stone is of a gritty nature, very similar to a bed of freestone found in some of the pits of Bonhar coal-field.

This then is the out-cropping of the Shotts coal-field, and as it is intimately connected with the coal-fields of West Lothian, it

may here be necessary to make a few remarks on it, in order to trace their connexion, and explain the particular characters of them both.

The whole Shotts minerals may be considered as lying in a basin, rising on all sides from about the place where the engine-pit from which the water is pumped is situated. It is a very extensive field, and has, for a long course of years, been worked to a very great extent. There are two seams of coal, the upper or main coal and the lower or stinking coal. The ironstone is found in balls above the coal, and is worked along with it in the *Following*. These balls are an excellent kind of ironstone, and the coal is well suited for calcining iron and for the furnace. There are three great faults in this field. The north one, which is a continuation of Bonhar south fault, runs from north-west to south-east, and is down to the north. The middle fault cuts off the Shotts field on the north. It runs in the same direction and passes about 17 fathoms south of Shotts engine-pit. The third fault runs in a similar direction and cuts off the Shotts field on the south.

Crofthead Ironstone and Coal-field.

Next in order below the Shotts minerals is a very fine field of ironstone, situated between Fauldhouse and the village of Longridge, which has lately been opened up. This field contains the Crofthead or slaty black-band ironstone, now so highly valued. On the lands of Wester Handax Wood, the slaty band was worked by the Wilsontown Iron Company, forty years ago, by mining, but the value of it was not then known, and it was supposed that it did not extend to the north side of Breich Water, whereas it has now been discovered that the greater part of the slaty black-band lies on the north side of Breich Water.

In working the seams of this ironstone it is found to occur thus :—

1*st*, Black blase, from 9 to 11 inches thick. This blase contains, in the upper part, balls of ironstone from 2 to 5 inches thick, which are called by the workmen the "*finestone*." On the bottom of this black blase there are sometimes found irregular nodular protuberances of ironstone, which are named by the workmen "*swirliemaggies*." These sometimes come from the bottom of the black blase down through the "maggie blase" and "maggie band" to the top of the "main stone" or "mid cleave," and, when they occur, considerably impede the operations of the miner.

2*d*, Below the black blase there is a lighter-coloured blase, named by the workmen the "*maggie blase*," which is 8 inches thick.

3d, The upper ply or "*maggie band*," as it is called, which is the upper seam of the slaty band, and is 3½ inches thick.

4th, The "*mid cleave*" or "*main band*," which is the principal seam, and is 7 inches thick.

5th, The "*bottom cleave*" or lower seam, 3 inches thick, which has from ½ an inch to 1 inch of coal adhering to the bottom of it.

These three seams of slaty band are in all, at an average, 14 inches thick.

The floor is a sort of wild coaly slate, below which there is very hard sandstone 4 feet thick.

About from 23 to 25 fathoms below the slaty band there is a bed of ironstone balls, called by the workmen "*Thomson's balls*," which lie in a bed of clay from 4 feet to 4½ feet thick, which clay is between beds of sandstone. These balls were at one time worked open-cast, by the Wilsontown Iron Company, on the south side of Breich Water, and contain the highest per-centage of iron as yet found in any stone in this neighbourhood.

On the south side of Breich Water, and in the county of Edinburgh, on the lands of Wester Handax Wood, where the slaty band was formerly worked by the Wilsontown Iron Company, the position of the minerals is well seen. There is an old day level and an air-pit, about 3 fathoms deep, and also an engine-pit, 7 fathoms deep, where the water was pumped, and ironstone raised by a high-pressure engine, the boiler of which burst in 1839, and killed five persons and severely wounded another, since which accident the minerals have not been here worked. The whole of the slaty band as yet worked in West Lothian is in tack by the Shotts Iron Company and Messrs Holdsworth of Coltness.

The Shotts Iron Company's pits are situated on the lands of Crofthead, and form the western limit at which this ironstone has as yet been worked in West Lothian. The minerals dip to the north-west 1 foot in 7, and thus these pits are also farthest to the dip. This company have at present two pits working; an engine-pit, 14 fathoms deep, worked by a condensing engine of 10-horse power, which pumps and winds; and a gin-pit. There was also another gin-pit, which is now worked out—it was the first pit opened by the Shotts Company, and had also an ingoing eye and a level.

There is also a bed of coal 11 fathoms above the ironstone; it is kept level, free, and is worked by an ingoing eye; there have also been several pits. The seam is about 2 feet thick.

Messrs Holdsworth's pits are all on the north side of the road from Fauldhouse to Breich toll. There are four pits—Eastfield pit, 23 fathoms deep, where there is a condensing engine of 26-horse power, which pumps and winds; Crofthead pit, 15 fathoms

deep, where there is a high-pressure engine of 12-horse power, which pumps and winds; Backcroft engine-pit, 14 fathoms deep, where there is a high-pressure engine of 6-horse power, which pumps and winds; and a gin-pit at Backcroft, 10 fathoms deep. There was also another pit near Crofthead pit, which is wrought out.

There are a number of hitches or slips and faults connected with the slaty band field.

The most important of these are the faults on the north and south of the Backcroft pits, of which the south one is understood to be the south fault at Bonhar, and the north fault at Shotts to the west, and a continuation of a fault which is seen at Breich Bridge, and the north fault at Longford, to the east. The only other one of much importance is known as the south fault, which runs from Bankhead on the south side of the Breich Water, and passes within a few fathoms on the south side of the Wilsontown Company's engine-pit at West Handax Wood, then within a little to the south of Turrviews, and between the Knows and Badalan, and on the south of Leadloch. This is understood to be the fault which runs through the centre of the Shotts field. It will be observed that the general direction of these faults is from north-west to south-east, that is, nearly in the direction of the dip and rise which is the general line of the faults throughout the whole of this district. There are also a number of smaller slips and hitches of minor importance, in general running in a similar direction, but some of them rather more inclined to the north. There is also a small slip at Greenburn, which is not within the limits of the plan of the workings by the Shotts Company—it is seen in the burn, and was also found in the coal level. It will be observed that none of these faults are dykes, properly so called, although usually so termed by the miners. The only real dyke in this neighbourhood is found running through the limestone quarry at Levenseat, in the county of Edinburgh; the limestone beds being quite regular in their position on each side of it. It runs in the same direction with the faults already mentioned. Where the ironstone is worked in the long-wall manner, a subsiding takes place of about 18 inches. Great care is required in regulating the air courses, and numerous air-pits are sometimes required in consequence of the great quantity of sulphureous vapour exhaled from the ironstone, and which sometimes issues in such quantity as to be troublesome, but it is only a suffocating, not an inflammable vapour.

The ironstone is removed on railways a short distance from the pits, where it is piled in large heaps, for the purpose of being calcined. These heaps vary in extent according as it is found most

convenient, and usually contain from a few hundred to two thousand tons of ironstone. At the Messrs Holdsworth's pits, on the bottom course and along the sides, the ironstone is broken into small fragments. The Shotts Company put a few coals on the lower course, which merely causes it to burn a little more rapidly, and it is for this purpose alone that the coal is worked at Crofthead. Previously to being set on fire the heap is carefully covered with engine-ashes, in order to exclude the air, otherwise the ironstone, where exposed, becomes oxidated, and assumes a brick-red colour. 100 tons of ironstone are, when calcined, reduced to 64 tons, and when well calcined it assumes an open and foliated appearance; when it has a solid and compact appearance, it is said to have got too much of the fire. The quantity of iron got from the raw stone is estimated by the Shotts Company at 42 per cent. This iron is, in consequence of its open texture, used for mixing with other kinds of iron when put in the furnace, in order to make them flow more easily. Whilst the ironstone is being calcined, the smoke has a very stifling effect, in consequence of the large quantity of sulphureous vapour given out along with it. Sulphur is found deposited on the top of the mass in large quantities, particularly where shale is burned along with it. On a mass of shale at Wester Handax Wood, which has burned for more than a year, but without decreasing in bulk, there is found about 4 or 5 inches of sulphur. It is thought that this mineral may yet be turned to valuable account in consequence of the large quantity of sulphur which it contains. The sulphureous vapour arising from the calcining of the ironstone has a most devastating effect upon the vegetation around, the ground in some places near the pits being totally devoid of vegetation. On the lands of Crofthead, a young plantation has been totally destroyed. When the water was pumped from the workings at Wester Handax Wood in June 1840, after having been in them for some time, it killed the fish in the Breich Water and in the Almond, into which it flows.

About from 45 to 48 fathoms below the bed of clay, ironstone balls, called Thomson's balls, which is called the "curly ironstone," is found. It is a bed of ironstone balls from 2 feet to $2\frac{1}{2}$ feet thick, lying below a mixture of sandstone and clay, the floor being composed of a bastard limestone from 1 foot to 16 inches thick. This ironstone is worked by the Shotts Company near Muldron, in the county of Edinburgh. 16 fathoms below this ironstone there is a bed of limestone, apparently belonging to the Levenseat limestone series, which lies below it. Below this the Wilsontown, Woodmuir, and Longford coals occur. This district, in which the slaty band occurs,

lies between the Levenseat limestone and the Drumgrey coal, which is mentioned by Mr Craig in his survey of the lower ward of Lanarkshire. There appears to be a great mass of sandstone between the slaty band series and the Levenseat limestone, as was found in a bore made on the east side of the road between Longridge and Whitburn. Whether this slaty band series extends much beyond the district in which it is at present worked is a somewhat doubtful point. Mr Craig states that it is found at Langside, in the parish of Shotts, and it is said to have been found south from Cult in the lands belonging to Sir William Baillie at Heads-farm, in the same neighbourhood, that is, about a mile and a-half north from Crofthead.

Boarbachlaw Coal.

The highest field of coal at the western extremity of the county connected with the Bathgate series of coal is the Boarbachlaw coal, which dips to the north by east. There was an old working south-west from the present working pits, where there were a number of faults. There are two seams of coal within these faults, the lower one of which is all worked out by a day level, the upper seam, which is unwrought, is 2 feet thick, above which there is a seam of ironstone 4 inches thick, which is capable of being worked along with the coal. The present working pits are outside of these dykes, they consist of an engine-pit, 9 fathoms deep, from which the water is pumped by an atmospheric engine of 10-horse power, and a working pit 16½ fathoms deep, where there is a gin for winding, which is worked by one horse.

Boarbachlaw Mill and Bathville Coals.

Below the Boarbachlaw coal there is a bed of coal called Boarbachlaw Mill coal, which was worked near Boarbachlaw Mill 23 years ago by a day level. It is rough coal, and dips in the same direction as Boarbachlaw coal. There is a black slate above it, and then fire-clay and grey blase, above which there is a bed of freestone, which formed the roof of the workings. Coal was also at one time worked at Bathville, south-east from Boarbachlaw Mill, where there were two pits, an engine-pit and a working pit. This is supposed to be the same bed as Boarbachlaw Mill coal, as they dip in the same direction, and as there is a bed of black slate above Bathville coal similar to that which occurs at Boarbachlaw Mill.

Colinshiel Coal.

The next in order after Boarbachlaw Mill and Bathville coal is the Colinshiel coal. At Colinshiel colliery a bed of coal is

worked exactly similar to Boarbachlaw coal, and is understood to be the same seam. It dips north-east scarcely 1 foot in 12. There are a few slips in Colinshiel coal-field running in the direction of the dip, none of which exceed 6 inches. There are 2 pits, an engine-pit, 12 fathoms deep, at which there is an atmospheric engine of 16-horse power, which pumps the water, and a working-pit, 13 fathoms deep, where there is a gin for winding, worked by one horse.

Colinburn Coal.

The next in order is the Colinburn coal, which lies 12 fathoms below the working seam of Colinshiel colliery. This intermediate space contains various seams of coal and ironstone. There is a fault on the south side of the Colinburn field, which runs from south-west to north-east, and which appears to be a continuation of a branch dyke or fault which runs from Boarbachlaw east fault, a little to the north of the Edinburgh and Glasgow road, and which was found in an old pit at Boarbachlaw; and at the east side of the mill it appears to be thrown down at least 40 fathoms. This coal was at one time worked north from Armadale, where there were a number of pits. In the bed of the Colinburn, about 400 yards north from Armadale, near some of the old pits, Colinburn coal is seen cropping out, lying under shale and ironstone bands. It is an excellent coal, a mixture of rough and splint coal, and is considered to be very like Bonhar coal; it dips 60 degrees north-east 1 foot in 3, and is capable of being worked along with the ironstone in the long-wall manner, the clay iron-band being excellent, and there being a rock roof. A good section of the strata lying below this coal is seen on the side of Boarbachlaw Burn near Boarbachlaw farm-house.

About 200 yards north-east from Killycantie, a thin seam of coal and good bands of ironstone were formerly worked, and at Byemuir, opposite Killycantie, ironstone in excellent balls, some of which are about a ton and a-half in weight, were worked by the Carron Iron Company in open-cast, and by mining under a bed of freestone 12 feet thick, above which there is a bed of clay containing clay-band ironstone. These ironstone balls are 11 fathoms below Colinburn coal. On the side of Boarbachlaw Burn, a little above this ironstone mine, a pit was sunk 16 fathoms deep to a bed of coal 5 feet thick, which lies 28 fathoms below Colinburn coal. The quantity of water in this pit was so great that it prevented the workings from being continued.

Bridgecastle and Bridgehouse Coal.

North from Colinburn, coal has been worked at Bridgecastle and Bridgehouse. It dips north-east the same as Colinburn coal,

and is supposed to belong to the same bed; it is also a splint and rough coal, and is from 21 inches to 3 feet thick. There appears to be a fault on the north-east side of Colinshiel engine-pit, between the pit and the ironstone mine near Killycantie, as the ironstone balls which were worked in that mine are not seen to the south, being thrown down. This fault cuts off the Bridgehouse coal before it reaches Colinburn. There are two pits at Bridgecastle, an engine-pit, where there is an atmospheric engine of 20-horse power, and a working pit. A short way east from Bridgecastle pits, the same bed of coal has been worked at Bridgehouse, where there is a high-pressure engine of 20-horse power.

There is a trap dyke which runs to the north-east, on the north-east side of the Bridgehouse coal-field, all the coal on the north side of which dyke is blind coal. It has been worked in the lands of Crawhill and Wallhouse, which is the same seam. It is seen at different places on the Avon Water, but it is all blind coal. Blind coal has also been found at the Woolmill on Boarbachlaw Water; it is on the north side of the whin dyke. There is also a whin dyke which runs through by the north side of Wallhouse, and which is seen again at Avon Bridge; this is to the north of the Bridgehouse dyke. The large mass of trap which lies on the north-side of Boarbachlaw Water extends from Shotts Kirk and West Craig's Inn, and appears to join the trap of the Bathgate Hills. A pit was sunk in Burnbrae Park, on the lands of Wallhouse, to the depth of 5 fathoms. This seam, which is good blind coal, is 2 feet and $\frac{1}{2}$ inch thick. It has not been worked to any great extent, and was considered well adapted for drying malt and oats. The strata in this pit were mostly composed of freestone, with a bed of shale lying above the coal and another below it. A bore was made 8 fathoms below the upper bed, in which coal was also found not very deep; it had a bastard bed of freestone below it. The same seam was wrought on the opposite side of the burn, on the lands of Crawhill, at a short distance from Crawhillhouse. It crops out to the north-east of the plantation called the "Desert," on the south bank of the Avon. Ironstone was wrought in this neighbourhood twelve years ago on the lands of Woodside, by an ingoing eye, within a few yards of Torphichen Bridge, on the south bank of the Avon, where it occurs in the form of balls.

[*The remaining part of this Essay, together with a coloured Geological Map of West Lothian, and a few Sections of Rock Strata, will be given in the following Number.*—ED.]

WILLIAM & CHARLES YOUNG,

MANUFACTURING

IRONMONGERS & WIRE MERCHANTS,

No. 128, High Street, Edinburgh.

CATALOGUE

OF

WROUGHT, AND ORNAMENTAL CAST IRON,

AND

WIRE WORK.

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INVISIBLE WIRE FENCES, to resist DEER, CATTLE, HORSES, SHEEP, and LAMBS.

W. & C. Y. would respectfully direct the attention of the Landed Proprietors and others, to their INVISIBLE WIRE FENCES, which, for durability, strength, economy, and lightness of appearance, are unequalled by any description now in use. Wherever these Fences have been introduced, they are superseding every other kind; and they can be erected at the prices quoted, in any part of Scotland, England, and Ireland. They are admirably adapted for the following purposes :—

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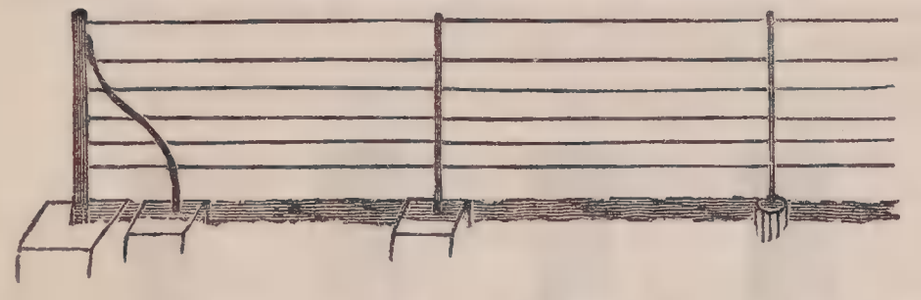
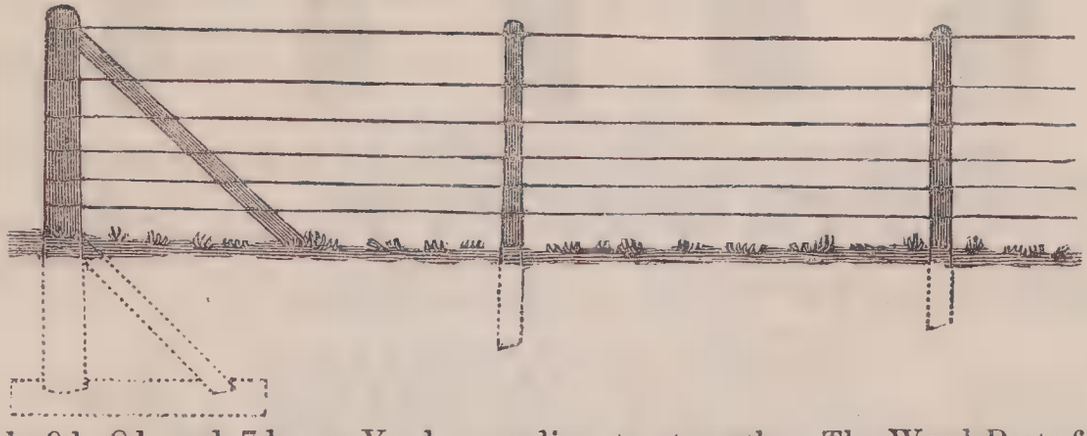


1/10, 1/8, 1/6, and 1/4 per Yard, according to strength.

WIRE FENCES STAPLED TO WOOD POSTS,
For Horses, Cattle, Sheep, and Lambs.



10d. 9d. 8d. and 7d. per Yard, according to strength. The Wood Posts furnished and put into the ground by the Proprietor.

This is a Fence which is unequalled for durability and economy, being cheaper than the most common Fence that can be put up.

☞ Exact estimates of cost given, on receiving a description, or taking a survey of the grounds where they are required.

PLAIN AND ORNAMENTAL WIRE FENCE, for enclosing Flower Gardens and Shrubberies, Hare and Rabbit Proof.

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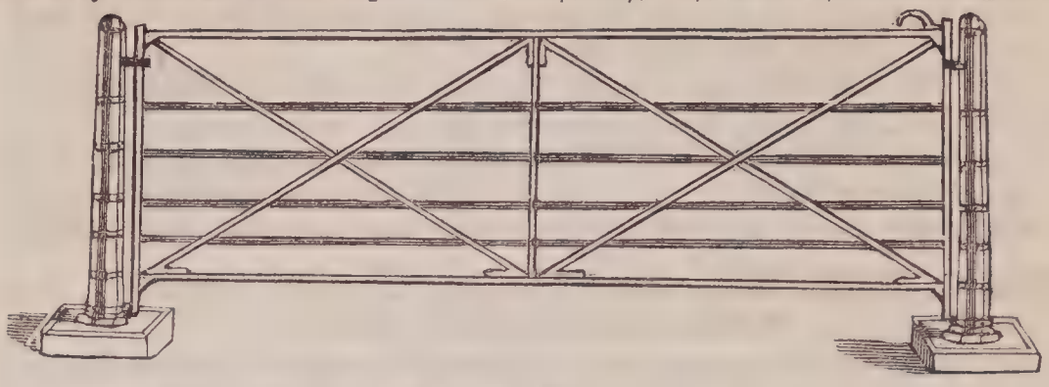
WROUGHT-IRON CARRIAGE GATES, to correspond with the Wire Fences, of very fine Workmanship. Prices, 50/, 60/, 70/, and 75/, according to size.



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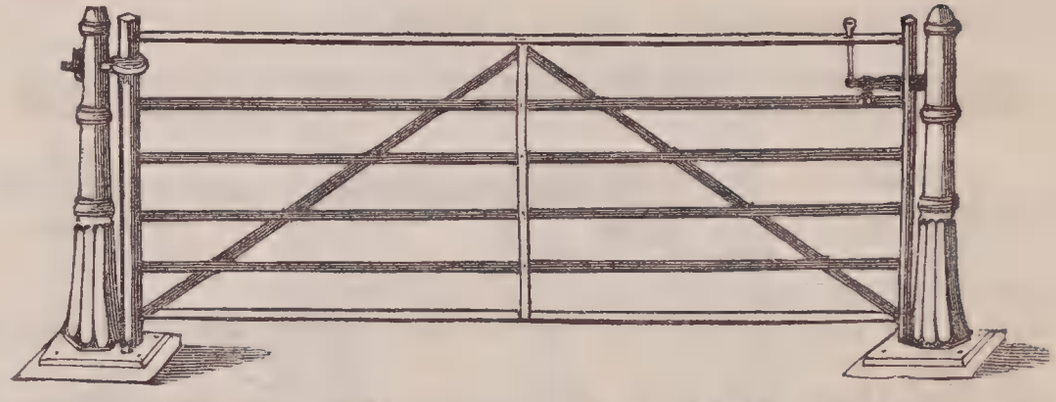

Prices, 25/, 27/6, 30/, and 35/ each; Complete, with Mounting for hanging them to Wood or Stone Posts.

CAST-IRON PILLARS for ditto, 20/ per Set.

WROUGHT-IRON ditto, with Back Stays, 17/ per Set.

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METALLIC HOTHOUSES, CONSERVATORIES, and GREENHOUSES, Planned and Constructed with the latest Improvements, and fitted up with the most approved Heating Apparatus for Hot Water.

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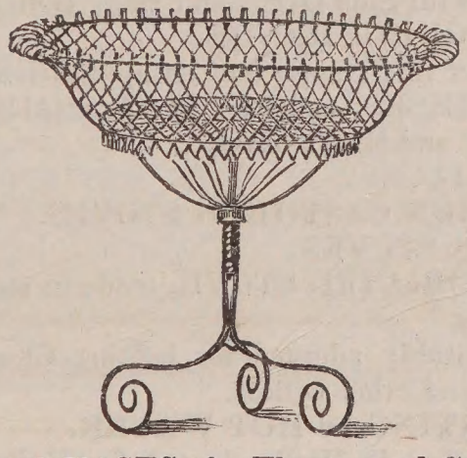

Prices, 10/, 15/, 18/, 20/, 25/, 30/, 35/, 40/, and 45/, each according to the pattern.

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ARCHES, ARBOURS, COLUMNS, and CANOPIES, made in IRON and WIRE, for the Training of Climbing Roses and other Creepers.
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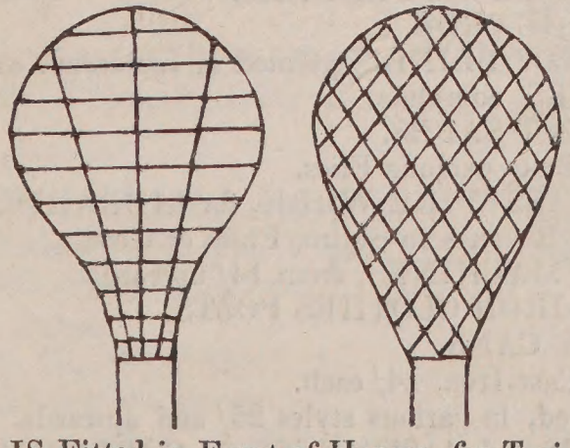
A great variety of Patterns in every Form requisite for Training.



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METALLIC WIRE for Tying Plants, 1/ to 1/6 per lb.
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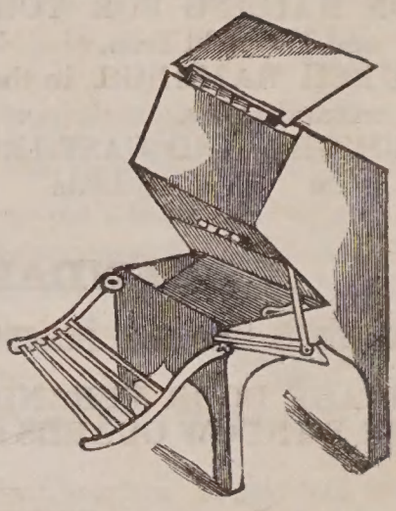
CONSTRUCTED OF IRON AND WIRE WORK.

LARGE PHEASANT BREEDING CAGES.

PHEASANT FEEDERS, Single and Double Perch.

The great economy of these Feeders is incalculable, and no preserve should be without them. They are so fitted that no bird lighter than the Pheasant can raise the lid.



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This method of Heating is Well adapted for Halls, Mansions, Churches, and other large buildings. It is safe, healthy, and economical

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NURSERY FIRE GUARDS and FENDERS.

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GAME and MEAT SAFES, complete.

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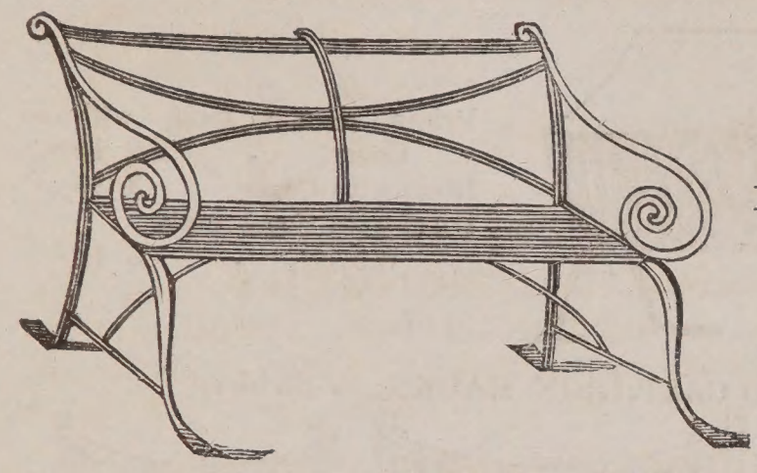
LETTER-COPYING MACHINES.
WROUGHT-IRON FRAMING for CHARTER BOXES.
FINE WROUGHT-IRON GARDEN CHAIRS, of various patterns.



Prices for two, three, and four Seats, 30/, 34/, 38/, Painted Green.

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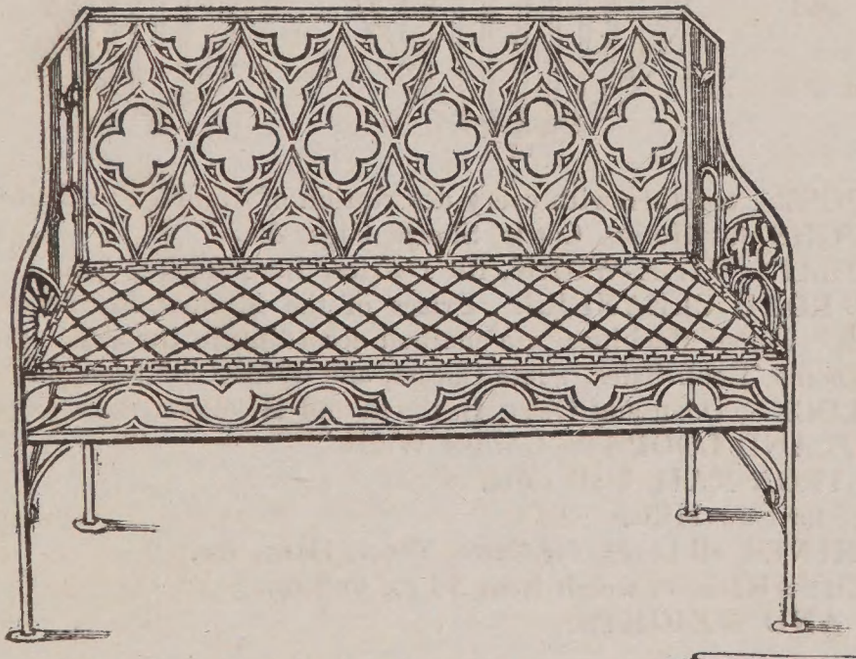

Prices,
One Seat, 24/
Two do. 28/
Three do. 34/
Four do. 38/

Made to come to pieces, and Painted Green.

WROUGHT-IRON SEATS, to go Round Trees.
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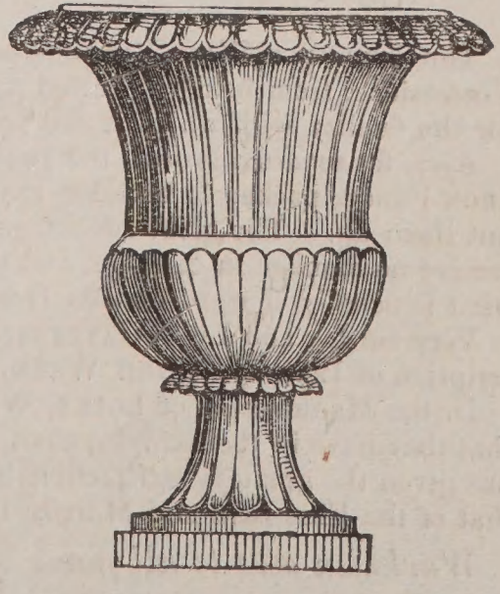

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MELON, CUCUMBER, & HAND GLASS FRAMES, of Iron, Copper, & Zinc.
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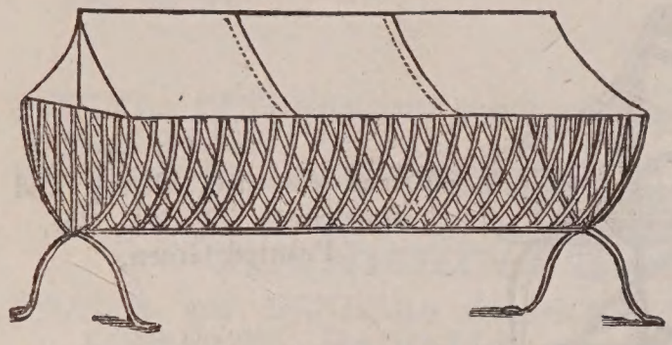
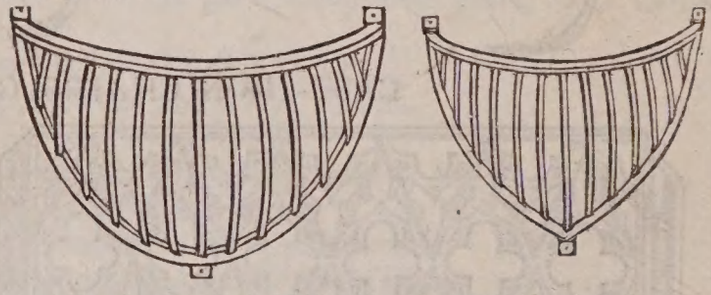


Prices, 6 feet long, without Cover, - £2 10/
Ditto with Cover, 3 10/
Ditto with Cover and Wheels, - 3 15/

WROUGHT AND CAST-IRON RACKS, for Stables,

Made in every Shape, Circular, Corner, and Bull's Eye.



MANGERS AND POSTS, together with every description of Stable Furniture.
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DIAMOND AND PLAIN WIRE-WORK, for Dairies, Larders, &c. &c.
WROUGHT-IRON ROAD CLEANERS. Prices of the Manual Machines, 66/ and 79/ each. Horse Machines are charged according to the size.
LOCKS for Gates, Rooms, Book-Safes, Plate Chests, and Wine Cellars, &c.
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